FISHERIES HABITAT EVALUATION IN TRIBUTARIES OF THE COEUR d'ALENE INDIAN RESERVATION

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EXECUTIVE SUMMARY

Bull trout and cutthroat trout are two species of salmonids native to the Lake Coeur d'Alene system. Historically, these species were fished by the Coeur d'Alene Indians. Cutthroat trout were once the most abundant trout species in the Coeur d'Alene system. However, since 1932, cutthroat trout have declined significantly. In addition, bull trout numbers have been greatly reduced in the last 100 years, and are currently of special concern. The population decline of both fish species has been attributed to heavy metal pollution, habitat degradation caused by grazing, agriculture and silvaculture practices, overharvest, and lake elevation changes that occurred during construction and subsequent operation of Post Falls Dam. By 1967 cutthroat trout comprised only 4% of the total catch in Lake Coeur d'Alene according to Rankel (1968).

The objective of this study was to conduct a baseline stream survey of tributaries located within reservation boundaries. In this survey habitat information related to improving spawning and rearing habitat was compiled. Accessibility to spawning tributaries for cutthroat and bull trout and existing fish stocks were evaluated. Two years were spent collecting baseline data to assess population dynamics, growth rates, behavior patterns and factors potentially limiting the fishery. Preliminary fishery improvement opportunities were identified based on the results of these data.

Relative abundance data resulted in the capture of 1,881 fish from May, July and September, 1992. A total of 349 cutthroat trout were collected from all sampled tributaries. Evans Creek had the highest relative abundance of cutthroat trout at 98.8%. No bull trout were captured in any of the surveyed tributaries

Population estimates were conducted in September, 1992. Density estimates for cutthroat trout were 1.4 fish/l00 m^2 in Benewah Creek, 11.8 fish/l00 m^2 in Alder Creek, 1.5 fish/l00 m^2 in Lake Creek and 33.0 fish/l00 m^2 in Evans Creek. Density estimates were also determined for eastern brook trout in Aider Creek (6.1 fish/l 00m^2). No bull trout were captured in any surveyed section and are assumed to be absent from the study areas.

Growth rates and condition factors for cutthroat trout captured in each stream tended to be comparable to other streams in

North Idaho. Eastern brook trout growth and condition factors were also comparable to those found in other streams in the region. Bull trout growth rates and condition factors could not be assessed because no bull trout were captured during the study.

Migration trap data indicated that Lake and Benewah creeks had a remnant population of adfluvial cutthroat trout as well as a resident population of cutthroat trout. Stocks on Alder Creek could not be determined from the data collected and Evans Creek retained only a resident population of cutthroat trout.

Habitat surveys were conducted on each of the four streams. Surveys showed that habitat was a limiting factor for cutthroat and bull trout survival in most of the watersheds . Land use practices within each selected watershed has contributed to the degradation of the fishery resources on the Coeur d'Alene Indian Reservation. Major habitat problems associated with the area included insufficient overwintering and rearing habitat as well as high sediment input from non-point sources which included agricultural (grazing and farming) and silvacultural (timber) practices. Stream systems located in low elevation drainages received their primary sources of water from snow melt run-off and rain events. Due to flow constraints (zero flow in summer) and adverse land use practices within the basins, these drainages, had limited resident fish production potential. However, perennial drainages could have existing land-use practices modified to enhance the habitat quality and quantity for cutthroat and bull trout.

The Coeur d'Alene Tribe identified two biological objectives for their fishery: 1) Restore tributary populations of native cutthroat and bull trout, which were historically prominent in the Lake Coeur d'Alene system; and, 2) Increase subsistence harvest. In order to successfully accomplish the above objectives three major goals were identified:

1) Protect existing stocks of native trout species located within the Coeur d'Alene Indian Reservation's jurisdiction.

2) Expand populations of native cutthroat and bull trout to levels above endangerment of extinction; and

3) Reestablish self-sustaining populations of cutthroat and bull trout in the Couer d'Alene system.

The first recommendation is for complete closure of the cutthroat trout and bull trout fishing in reservation tributaries. These closures will help protect declining stocks from mortality due to angler harvest during spawning migrations and those juveniles rearing in the system.

The Idaho Department of Fish and Game (IDFG) has imposed special fishing regulations on cutthroat trout in the Couer d'Alene System. Closure of cutthroat fishing has already been established during spawning periods. IDFG has also closed all bull trout fishing in the Lake Coeur d'Alene system. The tribe fully supports all of these decisions. However, the Coeur d'Alene Tribe has reviewed their hunting/fishing regulations and has closed cutthroat and bull trout harvest by both tribal members and non-Indians on waters of the reservation.

The Coeur d'Alene Indian Tribes' long term goal is for the tributaries to support self-sustaining populations of cutthroat and bull trout. In order to accomplish this it will be necessary to conduct habitat enhancement measures and additional fisheries investigations. Our second recommendation is that habitat enhancement be conducted on four tributaries (Lake, Benewah, Evans and Alder creeks) at necessary locations to increase recruitment to the population.

Tributaries were surveyed extensively and were considered severely damaged and degraded due to land use practices which included agriculture, grazing and silvaculture. Problems encountered included eroding stream banks, massive sediment loading resulting in high embeddeness, insufficient canopy, instream and overhanging cover. Waterfalls and debris jams in some streams posed migration barriers for cutthroat and bull trout. Animal keeping practices within the system were also major problems associated with almost all drainages. Vehicular traffic within and crossing the stream channel were also common problems. Numerous unauthorized dump sites were observed along the stream corridor.

This recommendation was approved by the Council in their 1987 Columbia Basin Fish and Wildlife plan upon completion of a baseline survey of reservation tributaries, unless the Coeur d'Alene tribe recommended another alternative. The Coeur d'Alene Tribe recommends that BPA fund the advanced design, construction, operation and maintenance for habitat improvements mentioned.

Technical design, labor, construction, operation and maintenance of habitat improvements will be administered by the Couer d'Alene Tribe using funding provided by BPA.

Since overharvest has been a major problem in the Coeur d'Alene System for a long period of time even with protection measures previously mentioned, the current population of cutthroat and bull trout will probably not be sufficient for rapid repopulation of the tributaries to carrying capacity. Most likely it will take several decades to rebuild these populations solely by natural reproduction. Consequently it will be necessary to supplement native populations to accomplish the goal of population expansion.

For the reasons mentioned above the third recommendation the Coeur d'Alene tribe has is that Bonneville Power Administration (BPA) fund design, construction, operation and maintenance of a low capital hatchery for cutthroat and bull trout on the Couer d'Alene Indian Reservation.

This recommendation was approved by the Council in their 1987 Columbia Basin Fish and Wildlife plan upon completion of a baseline survey of reservation tributaries, unless the Coeur d'Alene tribe recommended another alternative. Results of the baseline survey recommend that BPA fund the design, construction, operation and maintenance of a low capital hatchery facility on the Coeur d'Alene Indian Reservation. Hatchery design, land acquisition and environmental assessment should commence in 1994. The Coeur d'Alene Tribe should operate and manage hatchery via funding from BPA. This will partially mitigate the Coeur d'Alene Tribe for anadromous fish losses. .

The above measure should be monitored to determine effectiveness as outlined in the Power Council's Adaptive Management Policy. Therefore, it is recommended that all fishery enhancement projects (habitat improvements and supplementation efforts) be monitored for a three-year period after implementation to determine their effectiveness. The monitoring program should include:

1.) Creel survey to determine the number of angler hours, catch per unit effort by anglers, and catch and harvest rates for each species.

2.1 Population estimates of both hatchery raised and wild cutthroat and bull trout to determine if populations increase owing to habitat enhancement and stocking

3.) Growth rates of hatchery and wild fish stocks.

4.) Abundance of preferred prey organisms to determine the effect of stocking different numbers of fish on the ecosystem.

5.) A mark recapture study with various ages of hatchery released cutthroat and bull trout to determine if they remain in the tributaries or migrate into Lake Coeur d'Alene. Assess effectiveness of different locations, age or size at release and time of release for outplanting.

6.) Periodic assessments and quantification of habitat to ensure continuance of habitat improvement benefits.

Monitoring of hatchery outplanting and habitat improvements will provide important knowledge upon which future management decisions can be based.

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1 .O. INTRODUCTION

In 1987 the Northwest Power Planning Council amended the Columbia River Basin Fish and Wildlife Program, directing the Bonneville Power Administration (BPA) to fund, *"A baseline stream survey of tributaries located on the Coeur d'Aiene Indian Reservation to compile information on improving spawning habitat, rearing habitat, and* access *to spawning tributaries for bull trout (<u>Salvelinus confluentus</u>), cutthroat trout (<u>Oncorhynchus clarki</u>), and to evaluate the existing fish stocks. If justified by the results of the survey, fund the design, construction and operation of a cutthroat and bull trout hatchery on the Coeur d'Alene Indian Reservation; necessary habitat improvement projects; and a three year monitoring program to evaluate the effectiveness of the hatchery and habitat improvement projects. If the baseline survey indicates a better alternative than construction of a fish hatchery, the Coeur d'Alene Tribe will submit an alternative plan for consideration in program amendment proceeding."* In 1990, BPA contracted the Coeur d'Alene Tribe to perform this study. This report contains the results of the third year of the study and the Coeur d'Alene Indian Tribes' preliminary recommendations for enhancing the cutthroat and bull trout fishery on the Coeur d'Alene Indian Reservation. These recommendations are based on study results from year three data and information obtained in the first two years of the study.

1.1. Fisheries Management History of the Coeur d'Alene Basin.

See Graves *et al.* (1991) for a discussion of the past history of the study area.

1.2. Summary of 1990 and 1991 Findings

Twenty-one creeks, flowing into Lake Coeur d'Alene, and the St. Joe and St. Maries rivers, were initially identified within the study area as having habitat potentially suitable for trout species. **Data obtained from an aerial survey further determined that only ten** of the original twenty one creeks located within the Coeur d'Alene Indian Reservation contained potential trout habitat (Graves *et a/.* 1991). These tributaries included:

Fighting	Plummer
Bellgrove	Benewah
Lake	Hell's Gulch
Squaw	Evans
Little Plummer	Alder

The Missouri method of evaluating stream reaches was modified and used to rank the ten tributaries (Fajen and Wehnes 1981). This ranking, in combination with biological information collected, were used to determine the four streams with the best potential cutthroat and bull trout habitat. This work was accomplished by D. Chad Johnson for his masters thesis.

Biological data collected on the ten streams included; relative abundance data, trout population estimates, growth rates and benthic macroinvertebrate densities (Lillengreen et al 1993). Relative abundance data resulted in the capture of 6,138 fish from June, August and October, 1991. A total of 427 cutthroat trout were collected from all sampled tributaries. Relative abundance of cutthroat trout for all tributaries was 6.7%. Fighting Creek had the highest relative abundance of cutthroat trout (93.1%). Evans Creek, Lake Creek, Hells Gulch, Alder Creek, Benewah Creek, and Plummet-/Little Plummer creeks had relative abundances of 30.8%, 12.1%, II.I%, 3.3%, 2.1% and 0.5%, respectively. No bull trout were captured in any of the surveyed tributaries (Lillengreen *et al.* 1992).

Population estimates were conducted in only four of the ten tributaries due to intermittent stream conditions found during the summer on the other six selected streams. The four streams in which population estimates were conducted included Benewah, Alder, Evans and Lake creeks. Density estimates for cutthroat trout were 1.2 fish/l 00 m2 in Benewah Creek, 1.5 fish/l00 m2 in Alder Creek, 8.1 fish/l00 m2 in Lake Creek and 18.9 fish/l 00 m2 in Evans Creek. Density estimates were also determined for eastern brook trout in Alder Creek (11.8 fish/100m^2). No bull trout were captured in any surveyed section and are assumed to be absent from the study areas.

Growth rates and condition factors for cutthroat trout captured in each stream tended to be low in comparison to other streams in the region except for Benewah Creek (Lillengreen *et al.* 1992). Growth rates for cutthroat trout existing in Benewah Creek were comparable to other streams in the region. Eastern brook trout growth and condition factors were also comparable to those found in other streams in the region. Bull trout growth rates and condition factors could not be assessed because no bull trout were captured during the study.

Mean annual invertebrate densities in the tributaries ranged from 1,206 organisms/m2 in Alder Creek to 2,886 organisms/m2 in Evans Creek. Mean annual densities in the drift ranged from 21. organisms/m2 in Alder Creek to 266 organism/m2 in Evans Creek. Invertebrate densities were similar to other streams of the same size in the region. For a more detailed breakdown of invertebrate densities reference Lillengreen *et al.* (1992).

Land use practices within each selected watershed have contributed to the degradation of the fishery resources on the Coeur d'Alene Indian Reservation. Major habitat problems associated with the area included high sediment input from non-point sources which included agricultural (grazing and farming) and silvacultural (timber) practices. Stream systems located in low elevation drainages received their primary sources of water from snow melt run-off and rain events. Due to flow constraints (zero flow in summer) and adverse land use practices within the basins, these drainages, had limited resident fish production potential. However, perennial drainages could have existing land-use practices modified to enhance the habitat quality and quantity for cutthroat and bull trout.

Four out of the ten tributaries, Lake, Benewah, Evans and Alder creeks were chosen for further study based on their relatively high quality fisheries habitat and potential habitat enhancement opportunities.

1.3. Study Objectives

The objectives of this study were to:

* Conduct in-depth habitat evaluations of the four primary tributaries which included; estimates of amount of habitat (ie pools, riffle, cascades and side channels), estimate of instream and overhang cover; mass wasting (slope failure); bank cutting; vegetative type; and seral stage along stream corridor.

* Determine the population dynamics of trout species present in each tributary.

* Determine migratory behavior patterns of trout in each stream in order to assess stocks present (adfluvial, fluvial, or resident).

* Assess age, growth and condition of cutthroat and bull trout.

* Determine extent and effectiveness of cutthroat and bull trout spawning.

* Identify alternatives for restoring cutthroat and bull trout; Identify biological habitat restoration alternatives

* establish biological objectives based on restoration alternatives.

2.0. METHODS AND MATERIALS

2.1. Description of the Study Area.

The Coeur d'Alene drainage basin is located in the Idaho panhandle and extends approximately 9,583 square kilometers. It is divided into two subbasins, including the Coeur d'Alene River basin and the St. Joe River basin. The remainder of the drainage basin consists of streams flowing into Wolf Lodge, Corbin, Windy, Rockford, Mica and Cougar bays of Lake Coeur d'Alene (Figure 2.1).

The study area included four tributaries located within the Coeur d'Alene drainage basin; Lake, Benewah, Evans and Alder creeks.

The Lake Creek watershed (Figure 2.2) is located in southwest Kootenai County, Id. and southeast Spokane County, WA. Lake Creek discharges into Lake Coeur d'Alene at Windy Bay. Lake Creek is a third order stream and is approximately 21 kilometers long. Over half of the watershed is forested land while the remainder is agricultural land. Lake Creek is used as a domestic, as well as a limited livestock, water source.

The Benewah Creek watershed (Figure 2.3) is located in Benewah County, Id. and is a fourth order stream. Benewah Creek discharges in the southern portion of Benewah Lake, which since the raising of the water levels associated with the Post Falls Dam, is part of Lake Coeur d'Alene. Benewah Creek is approximately 24 kilometers long. Predominate land use practices within the watershed are grazing, timber and residential uses.

The Evans Creek watershed (Figure 2.4) is located in Kootenai County, Id. and is a second order stream. Evans Creek discharges into Medicine Lake, a lateral lake associated with the Coeur d'Alene River. Evans Creek is approximately ten kilometers long. Land uses associated with Evans Creek include silvaculture, grazing and residential uses. Evans Creek is used as a domestic and livestock water source.

The Alder Creek watershed (Figure 2.5) is located in Benewah County, Id. and is a fourth order stream. Alder Creek discharges into the St. Maries River and is approximately 20 kilometers long. The major land use practices within the watershed are

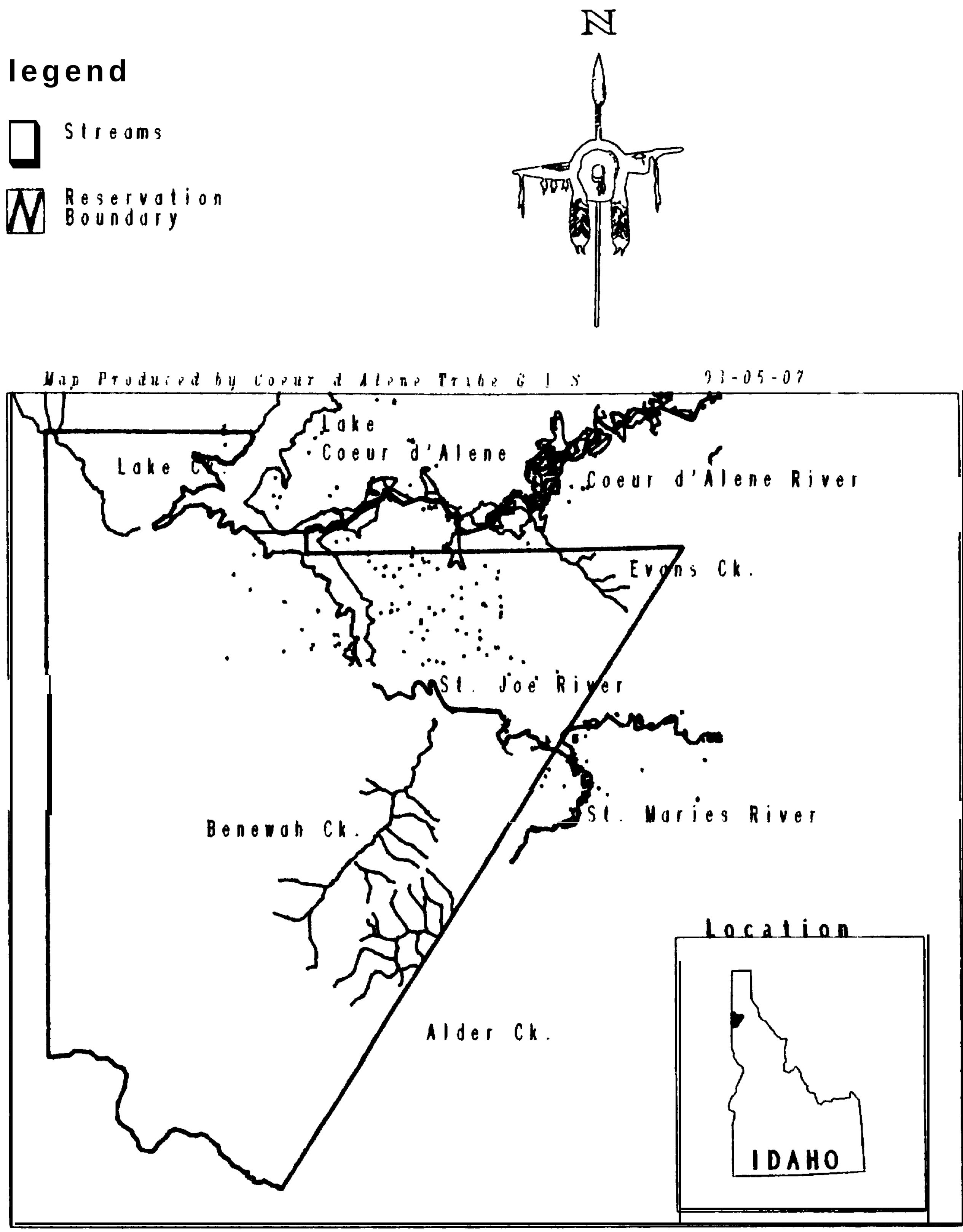


figure 2.1 Map Of the **Coeurd'Alene**lake Drainage

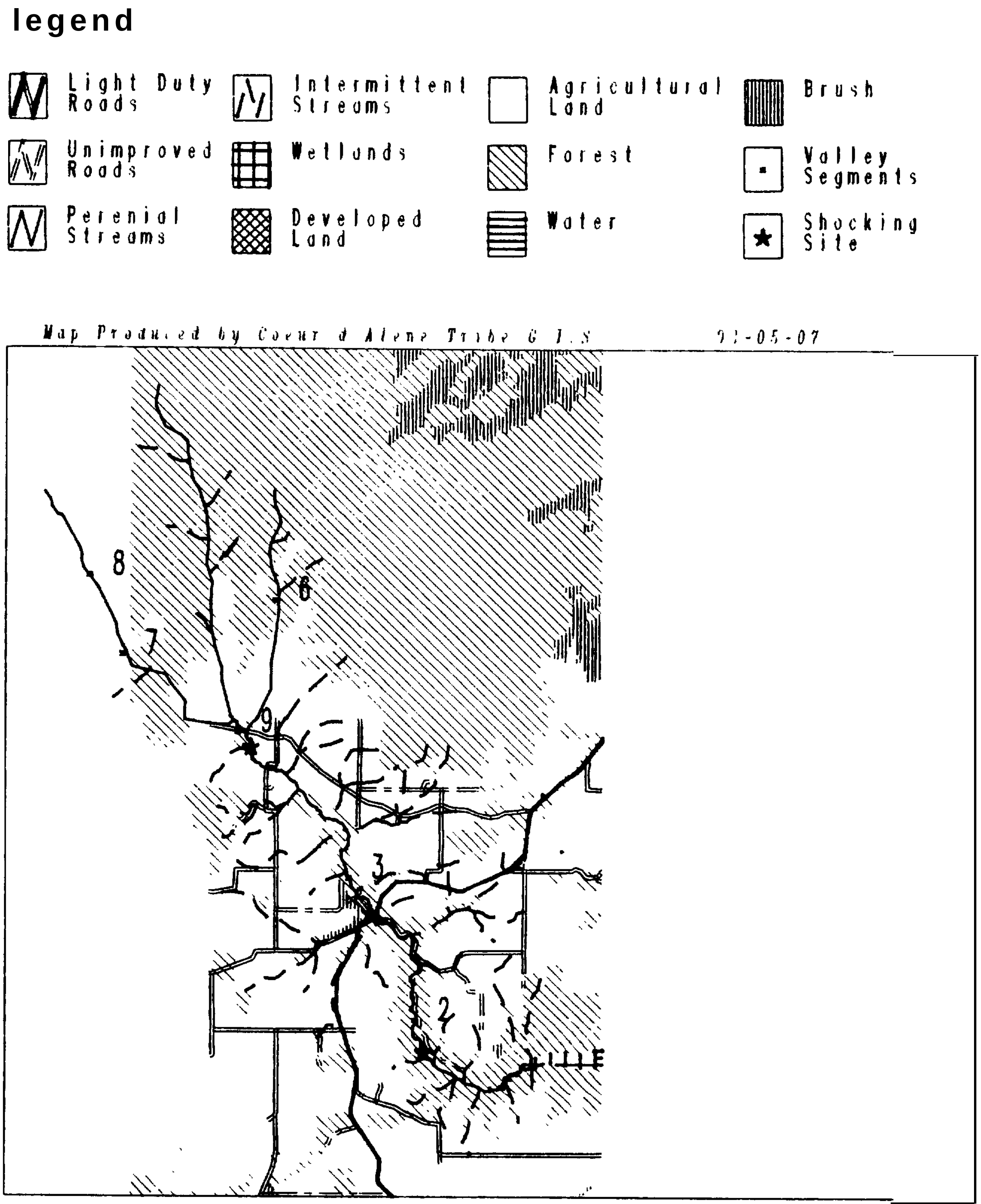


Figure 2.2 lake Creek Drainage

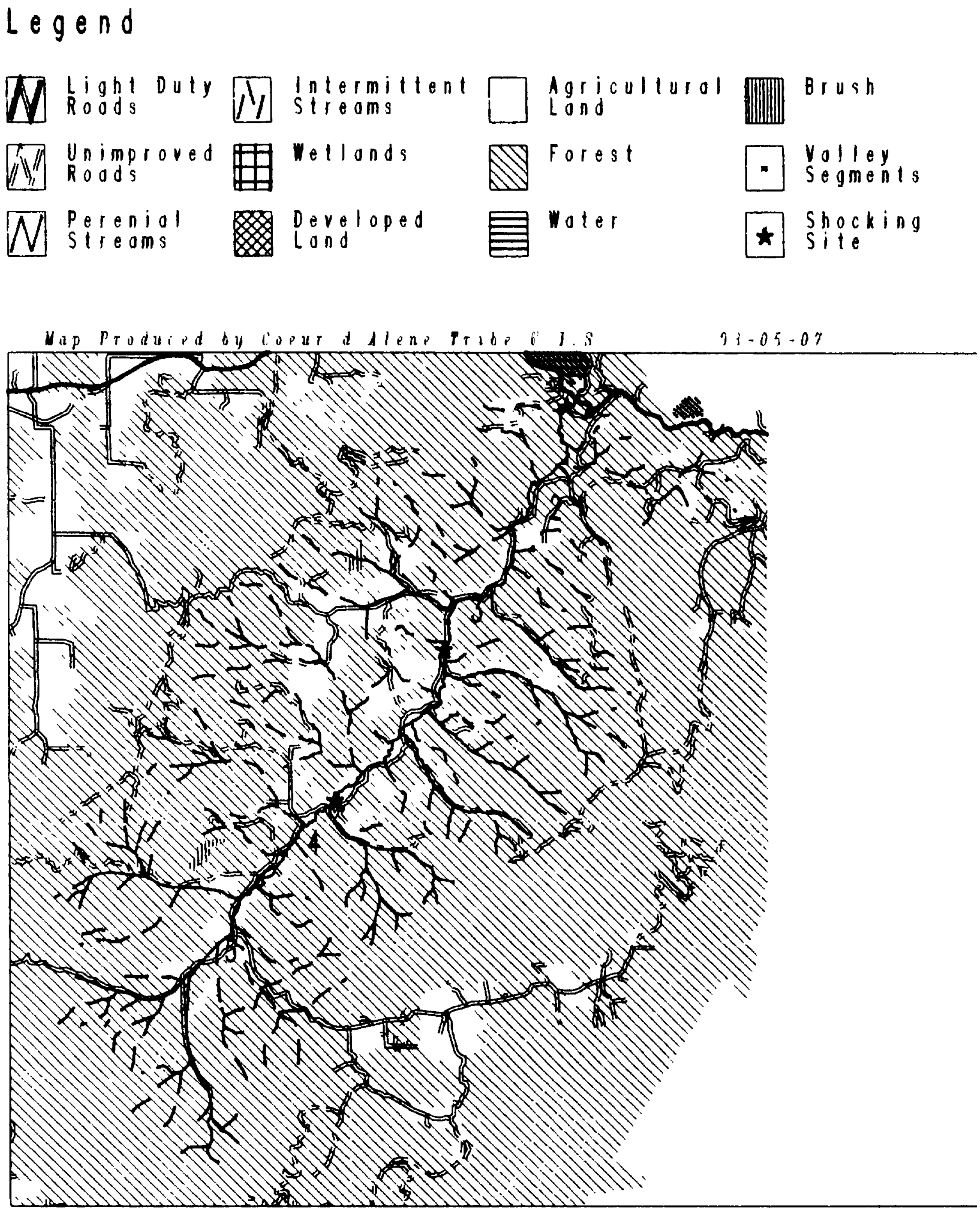
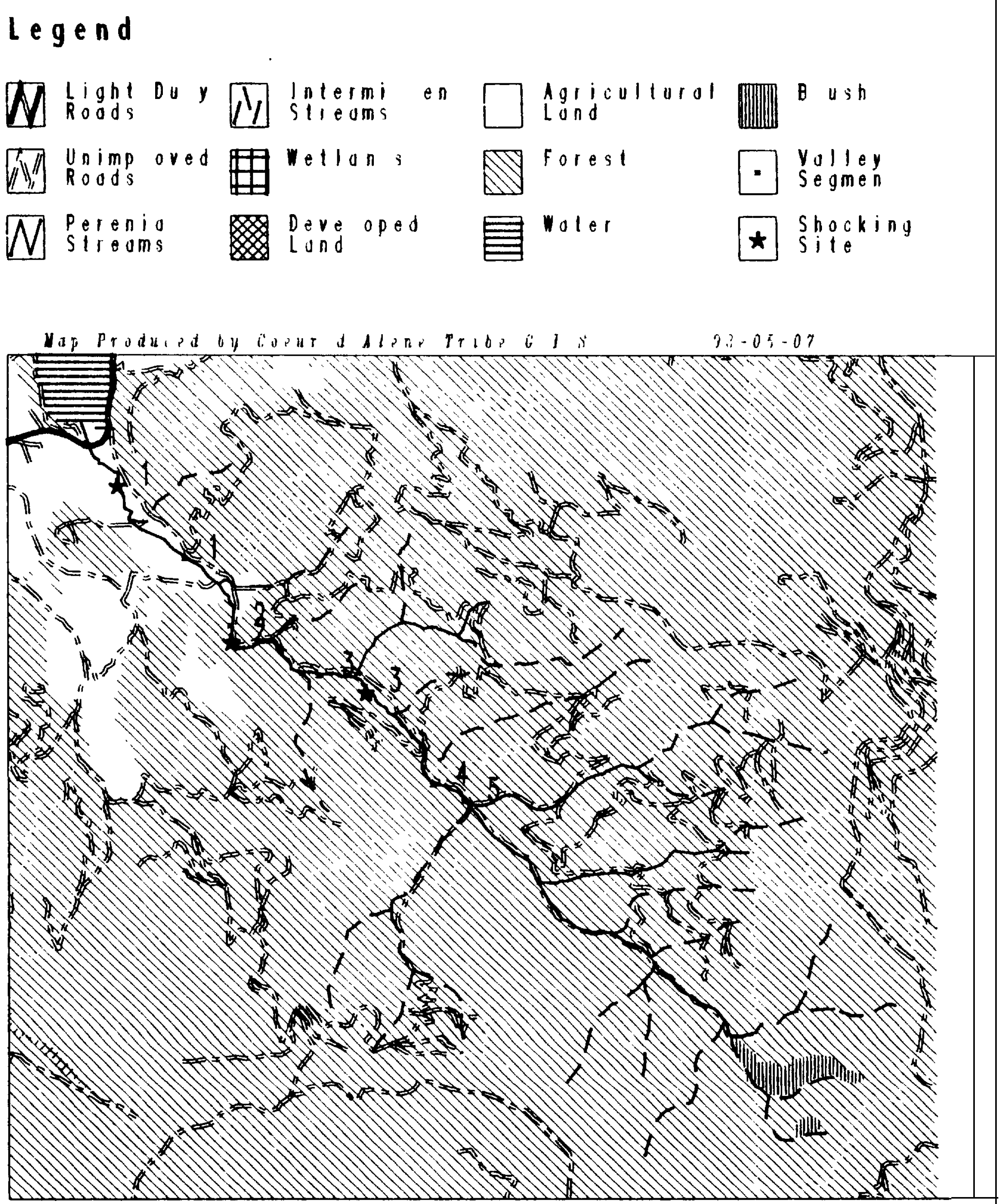


Figure 2.3 Benewah Creek Drainage



F_gure 2.4 Evans Creek Drainage

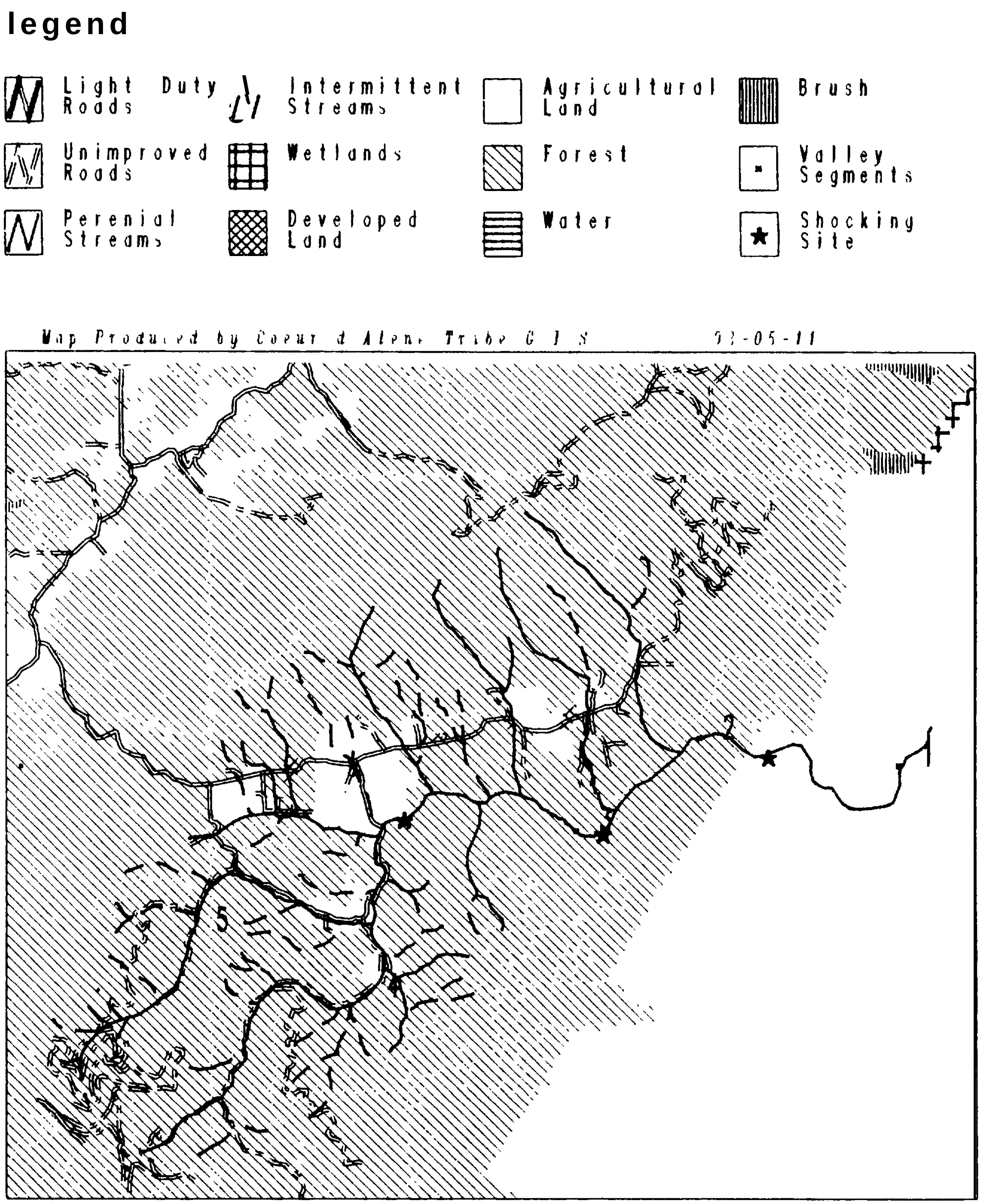


Figure 2.5 Alder Creek Drainage

private/industrial timber production and livestock grazing, Alder Creek is also used as a livestock and limited domestic water source.

2.2. Physical Investigations

Physical investigations were conducted on the four tributaries and included; habitat evaluations, stream reach channel stability profiles, discharge profiles, water quality analysis, and substrate analysis.

2.2.1. Habitat Evaluation of Primary Tributaries.

Habitat surveys were conducted on primary tributaries using modified methods of Timber/Fish/Wildlife Ambient Stream Monitoring Program (1991) (TFW) and Platts et al. (1983) during May-October, 1992. A crew of two walked the entire length of each stream channel from the confluence to the upstream limit of suitable trout habitat. Horizontal control surveys were conducted the first pass and habitat surveys were conducted during the second pass.

Horizontal Control Surveys

Streams were delineated into segments as outlined by Cupp (1989). Valley segment types (Frissell 1986) were defined by five general groups of characteristic features: 1) valley bottom longitudinal slope; 2) side-slope gradient; 3) ratio of valley bottom width to active channel width; 4) channel pattern and 5) adjacent geomorphic surfaces. These segments were identified on topographic maps and aerial photographs, and were easily verified in the field.

A field crew of two people walked the stream channel and established fixed reference points (horizontal control points) within each valley segment. These points were located along the stream channel above the high water mark so they could be easily identified in future field seasons. Each point was marked with aluminum tags and flagging. Distances between the fixed points were measured using a hip chain, as crew members followed the stream channel as closely as possible to account for channel turns. Distances were recorded on standardized data sheets. Compass bearings at each control point were recorded on standardized data sheets. Discharge measurements were made or estimated at the beginning of each valley segment. Stream gradient was measured every five horizontal control points using a Suunto Type 20 Clinometer. The presence of mass wasting and bank cutting was also noted and the length and area visually estimated for the entire length of stream and recorded on standardized data forms.

Habitat Surveys

A field crew of two **people** systematically surveyed the habitat of valley segments delineated in the horizontal surveys. Habitat sampling methods followed the procedures in the TFW ambient stream monitoring handbook (1991) with few modifications. One modification was that all habitat units were measured instead of using the visual estimation procedure. Fish habitat was classified into three broad categories; riffles, pools, and side channels. The first category riffle, was further defined into six riffle habitat types; glides or runs, pocket water, low gradient riffles, step pool cascades,slip face cascades, and rapids. The next category, pools, was divided into five habitat types; dammed pools, eddy pools, plunge pools, scour pools, and scour holes. The third category was classified as being side channels. Habitat units were categorized by the definitions found in Bisson et al. (1988) and can be found in Appendix A. Each habitat unit was then measured for length and width. Mean depth for riffle units and a minimum and maximum depth for pool units was measured. At every habitat unit, woody debris was counted, and categorized as logs or root wads. Diameter of the woody debris was estimated, location determined and function derived. The riparian condition was estimated by determining the canopy closure every five habitat units. This measurement provided an indirect measure of shading the stream received by adjacent riparian vegetation. One person stood in the middle of the channel unit and took four readings using a convex spherical densiometer. The measurements were taken facing upstream and downstream, and facing the right and left banks. The sectors of the densiometer that had vegetation in them were counted. The densiometer was divided into 24 sectors. Each sector was subdivided into four quarters. Each quarter had a possible score of 1, and each section had a possible score of four. All scores, for each direction, were summed and then divided by four to get an average score. This value was then subtracted from 96 and multiplied by 1.04 to give the percent canopy closure (Platts et *a/.* 1987). All canopy closure measurements within each stream reach were then averaged to determine the overall stream canopy closure percentage. The vegetation along the streambank was categorized as follows; visual estimates of the seral or successional stage of plant communities was made at every habitat unit. Type of dominant vegetation whether deciduous, coniferous or mixed, and land use, were documented.

Data Analysis

Data was recorded on standardized TFW forms and entered into R-BASE, a computerized data base located at the Northwest Indian Fisheries Commission in Olympia, Washington. A summary report of the data was then generated.

2.2.2. Stream Reach Index and Channel Stability Evaluation

The Stream Reach Inventory and Channel Stability Evaluation Procedure (Pfankuch 1975) was used to assess stream stability conditions. The stream reach index specifically targets and provides information about the capacity of streams to adjust and recover from potential changes in flow and/or increases in sediment production.

The stream reach inventory and channel stability evaluation was conducted on only those sections of streams where fishery surveys had taken place. Stream reaches were walked by a two member team and standardized data forms (Appendix C) were completed for each stream reach. Each reach was evaluated following the methods found in The Stream Reach Inventory and Channel Stability Evaluation Procedure (Pfankuch, 1975) and assigned a rating. Ratings were considered excellent when values were below 38, good when values were between 39-76, fair when values were between 77-l 14 and poor when values were above 115. Overall stream ratings were determined by multiplying the length of each reach by its numeric rating, summing the products and dividing by the total length of the stream sampled.

This inventory in conjunction with habitat surveys was used to assess habitat conditions and define impacts in stream reaches due to land use practices.

2.2.3. Stream Discharge Measurements

Stream discharge was measured monthly from February 1992 to November 1992, using a Price pigmy current meter in conjunction with a top setting wading rod following the methods of Buchanan and Somers (1980). Stream widths were measured and divided into at least 10 equal cells. Velocities were then measured at each cell at two thirds of total depth. Discharge was calculated with the formula:

$$Q = \sum_{i=1}^{n} \left(\frac{w_{i+1} - w_{i-1}}{2} \right) d_i \left(\frac{v_{i1} + v_{i2}}{2} \right)$$

where:

Q = Total discharge

n = Total number of individual sections

w_i = Horizontal distance from the initial point

d_i = Water depths for each section, and

v_i = Measured velocity for each section.

2.2.4. Water Quality Analysis

Water samples were collected seasonally. Tests for conductivity, dissolved oxygen, pH and temperature were conducted in the field using a Hydrolab Surveyor II. Water samples were also collected for laboratory analysis of nitrate, nitrite, phosphates, turbidity and alkalinity using a LaMotte Chemical colorimetric test kit. Total dissolved solids were determined using a HANNA model 0661-l 0 dissolved solids tester.

2.2.5. Substrate Analysis

Substrate samples were collected in each section of the stream to determine the amount of sediment deposition and to evaluate fry production. Each stream was divided into a lower, middle and upper reach. Within each reach, five sites were marked and two duplicate samples were collected at each site. A manual sampling method was used in which a garbage can with a diameter of 42 cm was inserted into the stream bed to a depth of eight inches.

The particles were then extracted by hand or shovel. The samples were wet-sieved in the field due to the remoteness of some of the sample sites. The sample was put in a bucket and the excess water was poured off. The sample was placed onto a series of sieves ranging from 64 mm to .18 mm. The excess water was allowed to drain off and then the sample retained on each sieve was poured into a graduated cylinder filled with water. The amount of water displaced was recorded. The error introduced by wet sieving, because of water present, was corrected using data on Table 2.1 found in Shirazi and Seim (1979). The percent weight in each size class was then calculated.

The Fredle Index provided an indicator of sediment permeability and pore size. The index was used to estimate the quality of the sampled substrate for trout reproduction (Platts et *a/.* 1983). The Fredle Index combined the measure of the central tendency of the distribution of the sediment particle sizes in a sample and the dispersion of particles in relation to the central value (Lotspeich and Everest 1981). This procedure characterized the suitability of the substrate for salmonid spawning, incubation and emergence. The formula used was;

$$fe = \frac{d_g}{S_o}$$

where:

fe = Fredle index

S_o = Sorting coefficient,

dg = Mean grain size based on the following formula:

$$d_g = (d_1^{w1} \times d_2^{w2} \times \ldots dnwn)$$

where;

dg = mean grain size

dn = the diameter at selected weights

w = weight at a selected diameter

So = Sorting coefficient based on the following formula,

$$So = \frac{d_{75}}{d_{25}}$$

This index indicates sediment permeability and pore size which are the two most influential factors governing salmonid embryo survival-to-emergence (Platts et *a/* 1983). With this index, substrate quality can be compared before and after habitat improvements are made.

Average survival to emergence for cutthroat trout was calculated for each substrate core site using the predictive equation for cutthroat trout developed by Irving and Bjornn (1984). This equation relates survival to gravel size. The equation used was:

$$\%\ Surv = 102.83 - 0.838(S_{9.5}) - 9.29\ (S_{0.85}) + 0.386\ (S_{0.85})^2$$

Where:

$\%S$ = Percent Survival

$S_{9.5}$ = % of substrate $\leq$ 9.5 mm

$S_{.85}$ = % of substrate $\leq$ .85 mm

Using this equation embryo survival was predicted at each core site based on the amount of fines present in the sample. The data was then combined to predict average emergence success of cutthroat trout for each reach of each tributary.

2.3. Fisheries Surveys

2.3.1. Relative Abundance

Fish relative abundance was determined by electrofishing using a Smith-Root Type VII pulsed-DC backpack electrofisher. Tributaries were sampled in May, July and September. Tributaries were divided into lower, middle and upper sections. Within each section, two random concurrent two-hundred foot segments were selected. Each section was electrofished using the standard guidelines and procedures described by Reynolds (1983). Fish captured were identified, counted, and measured to the nearest millimeter. A scale sample was removed below the dorsal fin from all salmonid species for age and growth analysis.

2.3.2. Population Estimates

Cutthroat and bull trout populations were estimated in the four streams in October 1992, using the removal-depletion method (Seber and LeCren 1967, Zippen 1958).

Six, two-hundred foot sections were randomly selected, to represent the longitudinal variation in habitat of each tributary. Blocknets were placed at the upstream and downstream boundaries to prevent immigration and emigration. Each section was electrofished using the standard guidelines and procedures described by Reynolds (1983). Fish were collected by spot shocking using a Smith-Root Type VII pulsed-DC backpack electrofisher. A minimum of two electrofishing passes were made for each two hundred foot section. Fish captured in the first pass were held in buckets until the second pass was made. Captured fish were identified, counted, and measured to the nearest millimeter. Cutthroat trout of 200 mm in length and larger were tagged with a Floy FD-6B numbered anchor tag. Scales were removed and weights taken from a representative group of each target species for age and growth and condition determination.

For each reach in which two passes were made, the population was estimated using the following equation of Seber and LeCren (1967):

$$N = \frac{(U_1)}{(U_1 - U_2)},$$

Where:

N = estimated population size;

U_1 = number of fish collected in the first pass;

and,

U_2 = number of fish collected in the second pass

The standard error of the estimate was calculated by:

$$S.E.(N)=\sqrt{\frac{(U_1)^2(U_2)^2T}{(UI-U2)}}$$

where:

SE.(N) = standard error of the population estimates; and

T = total number of fish collected (U_1+U_2)

When three or more passes were made in the section, the population was estimated using the methods of Zippin (1958). The first number needed was calculated by:

$$T = \sum_{i=1}^{n}(U_i),$$

where:

T = total number of fish collected

Ui = number of fish collected in the ith removal; and

n = the number of removals

The ratio (R) was then calculated using the equation:

$$R = \frac{\sum_{i=1}^{n} (i-1) U_i}{T}$$

The population estimate (N) was then calculated using the equation:

$$N = \frac{T}{Q}$$

where:

Q = the proportion of fish captured during all passes. Q was located by using the ratio (R) on the curve found in Fig. 22 of Platts et al. (1983).

The standard error of the estimate was calculated by:

$$S.E.(N) = \sqrt{\frac{N(N-T)}{T^2 - N(N-T)\frac{(kP)^2}{(1-p)}}}$$

where:

P = The estimated probability of capture during a single removal and is found using the ratio (R) on the curve found in Fig. 23 of Platts et al. (1983).

The 95 percent confidence intervals were placed around the estimate by multiplying the standard error by 1.96.

2.3.3. Spawning Surveys

Spawning surveys were conducted in late April and early May during 1992 to assess cutthroat trout spawning success. A two member field crew walked from the mouth of the stream to the upper limit of fish habitat. Redds were located, counted, classified and marked on topographic maps as described by Shepard and Graham (1983).

2.3.4. Migration Data

In March, 1992 upstream and downstream migration traps were installed in Lake, Evans and Benewah creeks. The upstream trap was placed approximately 200 yards from the downstream trap. Traps were not installed on Alder Creek due to inaccessibility. Traps remained in the streams until late June at which time they were removed. The trap design consisted of a weir, runway and a holding box (Figure 2.6). The design was a modification of the juvenile downstream trap found in Conlin and Ttuty (1979) (See Figure 2.7).

The traps were checked twice daily during peak spawning periods from March through the middle of May and once daily afterwards until late June. Fished captured in the traps were identified, counted, measured, weighed, and a scale sample was taken to assess the growth, condition and stock (fluvial/adfluvial/resident) of the fish.

2.3.5. Age, Growth, and Condition

Scales were used for age determination and calculating growth rates (Everhart and Youngs, 1981). Scales from the trout were taken below the dorsal fin. The area for scale removal is chosen based on size, large and consistent annuli, and shape (regular symmetry of the scale) (Carlander 1982; Bagenal and Tesch 1978). Scale samples were collected following methods of Jearld (1983). In the laboratory, several scales were mounted between two glass microscope slides and viewed using a Realist, Inc., Vantage 5 microfiche reader. The age was determined by counting the number of annulli (Lux 1971, Jearld 1983). Simultaneous to age determination, measurements were made from the center of the focus to the furthest edge of the scale. Along this line, the measurements were made to the nearest millimeter to each annulus

Figure 2.6. Picture of the Lake **Creek** migration trap-

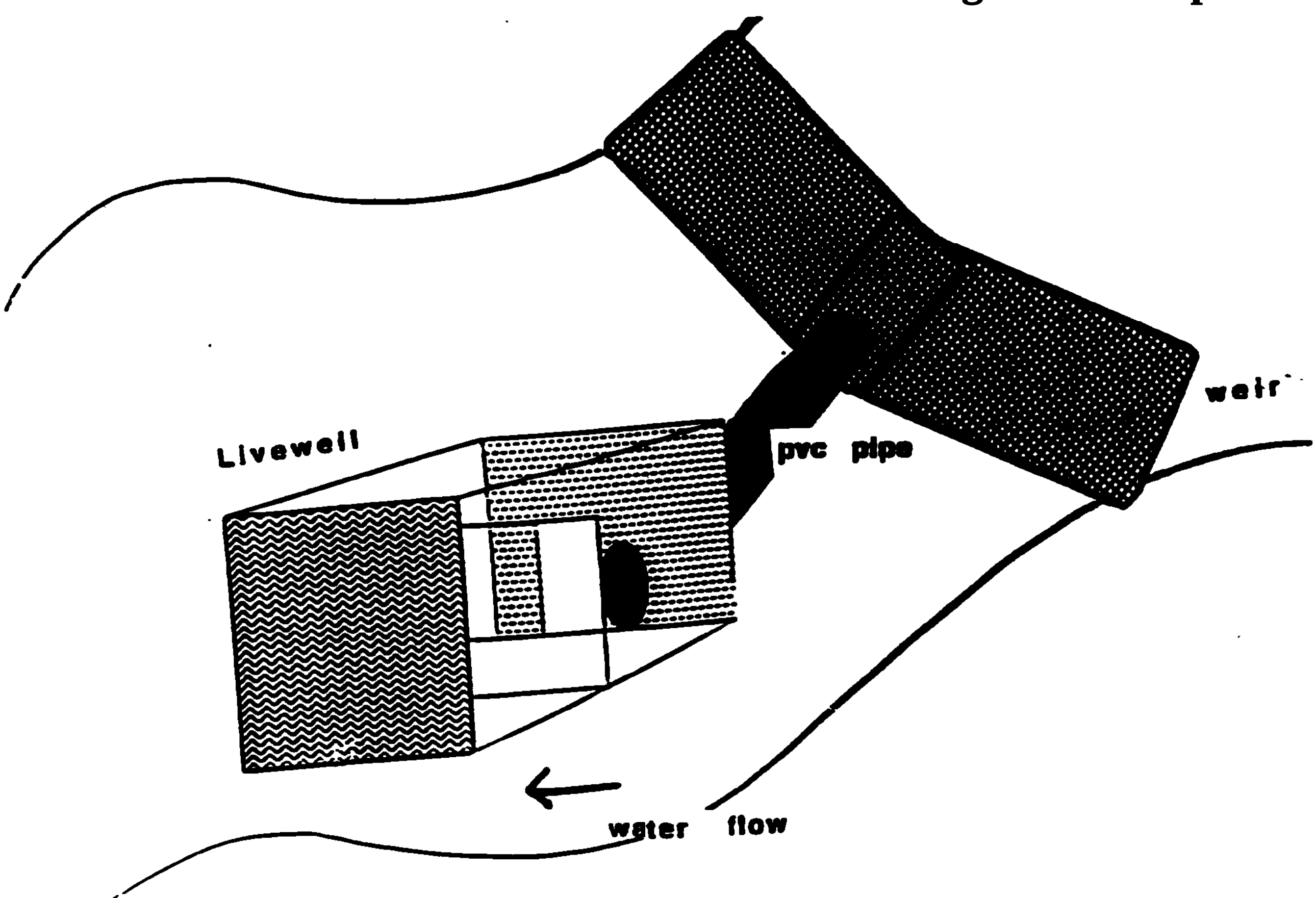


Figure 2.7. Diagram of **migration** trap installed in tributaries.

under a constant magnification. Annual growth was then back-calculated using the Lee method as described by Carlander (1981). The formula used:

$$Li = a + \left(\frac{(Lc - a)}{Sc}\right) Si,$$

where:	Li	=	Length of fish (in mm) at each annulus;
	a	=	intercept of the body scale regression line:
	Lc	=	length of fish (in mm) at time of capture;
	SC	=	distance (in mm) from the focus to the edge of the scale; and
	Si	=	scale measurement to each annulus.

The intercept (a) was obtained from the regression anafysis of body length -v- scale length at time of capture. The regression analysis was accomplished using StatView 512+ on a Macintosh SE computer. .

The proportional method of back-calculation was used for species with small sample sizes due to poor regression results. The following equation was used:

$$Li = \frac{Si}{Sc} Lc$$

This formula does not take into account the size of fish at scale formation as does the Lee method.

Condition factors were computed as an indicator of the fishes growth pattern and, therefore, an indication of its general condition (Everhart and Youngs 1981). The formula used to calculate the condition factor was:

$$K_{tl} = \left(\frac{W}{L^3}\right)10^5$$

Where:	K_{tl}	=	condition factor:
	W	=	weight of fish in grams; and
	L	=	total length of fish in millimeters.

Calculated condition factors were compared to other streams in the Pacific Northwest.

3.0 RESULTS

3.1. Physical **Investigations**

3.1.1. **Habitat Evaluation of Primary Tributaries**

Habitat summary reports were generated for all valley segments of each tributary. Valley segments were based on the channel typing of Cupp (1985). Habitat typing was completed after other data collection sites had been established, therefore, habitat segments were divided into more reaches. These were then combined, when appropriate, to determine the overall habitat conditions within each stream reach. Those segments that were not included in the reach designation have been included in Appendix B and may be referenced to determine the habitat conditions present.

3.1.1.2. **Lake Creek**

The Lake Creek drainage was divided into seven valley segments. Approximately 20 kilometers of the Lake Creek watershed were surveyed during 1992. Four valley segments comprised the mainstem of Lake Creek and three valley segments surveyed were tributaries to Lake Creek. These included Bozard and West Lake Creeks.

Surveyed sections of Lake Creek ranged in elevation from 652 to 841 meters. Stream order ranged from one to three and had an average stream gradient of 1.4. Primary land uses practices in the watershed included; forest (70.2%), agriculture (22.2%), livestock grazing (6.2%), mining (2%), and other (1 .O%) which included residential, urban and right of way access. (Table 3.1). For the entire watershed 437 habitat units were classified (Table 3.2) comprising a total area of 64,631 square meters. Of the 437 habitat units, six (1.4%) were identified as cascades, 318 (72.6%) as riffles, as 107(24.6%) as pools (Table 3.2).

For the lower reach of Lake Creek, valley segments one and two were combined. Elevation in the lower reach of Lake Creek began at 652 meters and rose to 732 meters in 4,187 meters. Mean stream gradient was 1.4%. Primary land use practices were forest (97.1%), mining (0.8%) and other (2.0%). The riparian area was dominated by a mixed vegetative stand that was 50.6% mature forest, 22.0% shrub, 17.9% grass/forb, and 8.6% pole. Canopy cover

Table 3.1. Summary report for Lake Creek (including Bozard and West Lake Creeks), May-August, 1992.

Elevation	652-841 m
Total length	20,875.1 m
Stream order	1 - 3
Mean stream gradient	1.4% (0.8%-2.0%)
Pool/riffle/cascade ratio	1/7.8/0.1
Land use	
Timber	70.2%
Agriculture	22.2%
Livestock grazing	6.2%
Mining	0.2%
Other (includes residential etc.)	1.0%
Vegetative type	
Deciduous	0.3%
Coniferous	0.3%
Mixed	99.4%
Seral Stage	
Grass/forb	22.5%
Shrub	31.5%
Pole	3.7%
Young	14.9%
Mature	27.1%
Old growth	0.4%
Other	
x Canopy cover	5.2% (0.0-l 9.7)
# Woody debris	
Logs	344
Root wads	20
Mass Wasting	

Table 3.2 Frequency of occurrence, total percent occurrence, total area and percent area for habitat types on surveyed areas of the Lake Creek drainage, including Bozard and West Lake Creeks, May-August, 1992.

Habitat Type	Frequency	% Frequency	Total Area (sq. meters)	% total
Rapid (RPD)	2	0.5	10	co.1
Step-pool cascade (SPC)	1	0.2	38	co.1
Slip-face cascade (SFC)	3	0.7	38	<0.1
Total Cascades	6	**1.4**	86	**0.1**
Pocketwater **(PKW)**	30	6.9	9,507	14.7
Glide (GLD)	128	29.3	26,208	40.6
Run (RUN)	0	0.0	0	0.0
Low gradient riffle (LGR)	160	36.6	21,525	33 3
Total Riffles	**31 8**	72.6	57,240	88.6
Damned pool **(DMP)**	6	1.4	657	1.0
Eddy pool **(EDP)**	3	0.7	58	0.1
Plunge pool **(PLP)**	14	3.2	535	0.8
Scour pool (SCP)	78	17.9	5,290	8.2
Scour hole (SCH)	6	1.4	282	0.4
Beaverpond (BVP)	0	0.0	0	0.0
Total Pools	**107**	24.6	6,822	**10.5**
Secondary channel (SDC)	6	1.4	483	0.8
Grand Totals	437		64,631	

ranged from 0-99% with a average of 18.1%. Two hundred forty-four logs and 18 root wads were counted in this reach. No mass wasting or bank cutting was observed in this reach (Table 3.3).

In the lower reach, 178 habitat units were categorized for a total area of 18,947 m? Six (3.4%) of the units were classified as cascades , 133 (74.7%) were riffles, 36 (20.3%) were pools and three (1.7%) were side channels (Table 3.4). Within the cascade category, three (1.7%) were slip face cascades for a total area of 37 m^2, two (1 .l%) were rapids for a total area of 10 m^2 and one (0.7%) was a step pool cascade for a total area of 38 m^2. Within the riffle category, 58 (32.6%) were low gradient riffles for a total area of 5,472 m^2, 46 (25.8%) were glides for a total area of 2,333 m^2 and 29 (16.3%) were pocketwater for a total area of 9,302 m^2. In the pool category, 21 (11.8%) were scour pools for a total area of 1,071 m^2, and eight (4.5%) were plunge pools for a total area of 195 m? Three (1.7%) scour holes, eddy pools and one (0.6%) dammed pool were also identified for total areas of 73m^2, 58m^2, and 28m^2, respectively. Calculated mean residual pool depths were 0.13 m for dammed pools, 0.24 m for eddy pools, 0.34 m for plunge pools, 0.47 m for scour pools and 0.60 m for scour holes (Table 3.4).

For the middle reach of Lake Creek only valley segment three was included. Elevation in this section ranged from 732 to 765 meters (Table 3.5). Total segment length was 4,172 meters and the average stream gradient was 1.4%. A pool/riffle/cascade ratio of 0.19/1/0 was calculated. Land use practices in the middle reach included forest (89.6%), agriculture (9.2%), livestock grazing (9.2%) and other (1.2%) which includes residential and right away. The riparian area is dominated with a deciduous stand of mature timber (89.6%) and grass/forb (9.2%).

In the middle reach, 163 habitat units were counted and identified. One-hundred-twenty-two (74.9%) were in the riffle category, 38 (23.3%) were in the pool category and 3 (1.8%) were identified as secondary channels for a total of 19,144 m2. Within the riffle category, 51(31.3%) were glides for a total area of 8,101 m^2, and 71 (43.6%) were low gradient riffles for a total area of 16,054 m2. In the pool category, 36 (22.1%) were scour pools for a total area of 2,585 m^2, and scour holes and dammed pools each one (0.6%) for total areas of 132 m^2 and 211 m^2, respectively (Table

Table 3.3. Summary report for lower Lake Creek*, May-August, 1992.

Elevation	652-732 m
Total length	4,167 m
Stream order	3
Mean stream gradient	1.4%
Pool/riffle/cascade ratio	1/12.6/.06
Land use	
Timber	97.4%
Agriculture	
Livestock grazing	
Mining	0.8%
Other (includes residential etc.)	20%
Vegetative type	
Deciduous	0.9%
Coniferous	
Mixed	99.1%
Seral Stage	
Grass/forb	17.9%
Shrub	22.0%
Pole	8.6%
Young	50.6%
Mature	0.7%
Old growth	
Other	
x Canopy cover	18.1%
# Woody debris	
Logs	244
Root wads	18
Mass Wasting	0

*(includes valley segment #1 and #2).

Table 3.4. Frequency of occurrence, total percent occurrence, total area, percent area, and residual pool depth values for the lower reach* of Lake Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	2	1.1	10	<0.1	
Step pool cascade	1	0.6	38	0.2	
Slip face cascade	3	1.7	37	0.2	
Total Cascades	**6**	3.4	85	0.4	
Pocketwater	29	16.3	9,302	49.1	
Glide	46	25.8	2,333	12.3	
Run	0	0.0	0	0.0	
Low gradient riffle	58	32 6	5.472	28 9	
Total Riffles	**133**	74.7	17,107	90.3	
Dammed pool	1	0.6	38	0.2	0.13
Eddy pool	3	1.7	58	0.3	0.24
Plunge pool	8	4.5	195	1.o	0.34
Scour pool	21	11.8	1,071	5.7	0.47
Scour hole	3	1.7	73	0.4	0.60
Beaver pond	0	0.0	0	0.0	0.00
Total Pools	36	20.3	**1,435**	7.6	
Secondary channel	3	1.7	320	1.7	0.10
Grand Totals	**178**		**18,947**		

*(includes valley segment #1 and #2).

Table 3.5. Summary report for middle Lake Creek*, May-August, 1992.

Elevation	732-765 m
Total length	4,172 m
Stream order	3
Mean stream gradient	1.4%
Pool/riffle/cascade ratio	.19/1.0/0
Land use	
Timber	89.6%
Agriculture	9.2%
Livestock grazing	9.2%
Mining	
Other (includes residential etc.)	1.2%
Vegetative type	
Deciduous	98.9%
Coniferous	
Mixed	1.1%
Serai Stage	
Grass/forb	
Shrub	9.2%
Pole	
Young	89.6%
Mature	
Old growth	
Other	
x Canopy cover	0.0%
# Woody debris	
Logs	19
Root wads	1
Mass Wasting	0

3.6). Average residual pool depths were calculated at 0.91 meters for dammed pools, 0.55 meters for scour pools and 0.82 meters for scour holes.

The upper reach of Lake Creek consisted of valley segment #4. Elevation ranged from 765 to 780 meters and measured 5,075 meters in length. Average stream gradient was 1.3% and a pool/riffle/cascade ratio of 0.15/1/0 was calculated. Land use practices in this reach consisted mainly of agriculture (77.9%) forest (7.0%) and residential (1.2%) (Table 3.7). A 100% mixed stand existed in this area with a predominate seral stage of grass/forb (51.2%) followed by mature timber at 48.8%. No 'canopy cover existed in this reach of Lake Creek. Fifty three logs and one root wad were counted in this section. No mass wasting or bank cutting were observed.

In the upper reach 43 habitat units were counted for a total area of 16,160 m^2. Thirty one (72.1%) were in the riffle category and 12 (27.7%) were in the pool category (Table 3.8). Within the riffle category 19 (44.2%) were identified as glides (44.2%) for a total area of 12,359 m^2 and 12 (27.9%) were low gradient riffles for a total area of 430 m? Dammed pools, scour pools, and scour holes were identified within the pool category at 4 (9.3%), 6 (14.0%) and 2 (4.7%) respectively (Table 3.8) for total areas of 409 m^2, 1585 m^2, and 77 m^2, respectively. Residual pool depths were calculated at 0.53 m, 0.27 m, 0.68 m, and 0.59 m for dammed, plunge, scour pools and scour holes, respectively.

Habitat typing was conducted on more valley segments within Lake Creek, however data collection did not occur in these areas. Correlation of habitat and fisheries data can not be conducted for these valley segments, but the habitat surveys can be found in Appendix B.

3.1.1.3. Benewah Creek

Benewah Creek was divided into five valley segments. Approximately 19 kilometers of the Benewah Creek watershed were surveyed during 1992.

Surveyed sections of the Benewah Creek drainage ranged in elevation from 683 to 853 meters. Stream order ranged from one to four and had an average stream gradient of 2.1. Primary land uses practices in the watershed included livestock grazing (54.%), timber

Table 3.6. Frequency of occurrence, total percent occurrence, total area, percent area, and residual pool depth values for the middle reach* of Lake Creek May-August, 1992.

Habitat Type	Frequency	% Frequency	Total Area (Sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0.0	0	0.0	
Step pool cascade	0	0.0	0	0.0	
Slip face cascade	0	0.0	0	0.0	
Total cascades	**0**	**0.0**	**0**	**0.0**	
Pocketwater	0	0.0	0	0.0	
Glide	51	31.3	8,101	42.3	
Run	0	0.0	0	0.0	
Low gradient riffle	71	43.6	7,953	41.5	
Total riffles	**122**	**74.9**	**16,054**	**83.8**	
dammed pool	1	0.6	211	1.1	0.91
eddy pool	0	0.0	0	0.0	0.00
plunge pool	0	0.0	0	0.0	0.27
scour pool	36	22.1	2,585	13.5	0.55
scour hole	1	0.6	132	0.7	0.82
Beaver pond	0	0.0	0	0.0	
Total pools	**38**	**23.3**	**2,928**	**15.3**	
Secondary channel	3	1.8	162	0.9	0.38
Grand totals	**163**		**19,144**		

* (includes valley segment # 3)

Table 3.7. Summary report for upper Lake Creek*, May-August, 1992.

Elevation	765-780 m
Total length	5,074 m
Stream order	3
Mean stream gradient	1.3%
Pool/riffle/cascade ratio	.15/1.0/0
Land use	
Timber	7.0%
Agriculture	77.9%
Livestock grazing	13.9%
Mining	
Other (includes residential etc.)	1.2%
Vegetative type	
Deciduous	
Coniferous	
Mixed	100%
Seral Stage	
Grass/forb	51.2%
Shrub	
Pole	
Young	48.8%
Mature	
Old growth	
Other	
x Canopy cover	0.0%
# Woody debris	
Logs	53
Root wads	1
Mass Wasting	0

* (includes valley segment # 4)

Table 3.8. Frequency of occurrence, total percent occurrence, total area, percent area, and residual pool depth values for the upper reach* of Lake Creek May-August, 1992.

Habitat type	Frequency	% Frequency	Total Area (sq. m)	% Area	Residual pool depth (m)
Rapid	0	0.0	0	0.0	
Step pool cascade	0	0.0	0	0.0	
Slip face cascade	0	0.0	0	0.0	
Total Cascades	**0**	**0.0**	**0**	**0.0**	
Pocketwater	0	0.0	0	0.0	
Glide	19	44.2	12,358	76.5	
Run	0	0.0	0	0.0	
Low gradient riffle	12	27 9	1.729	10 7	
Total Riffles	**31**	**72.1**	**14,089**	87.2	
dammed pool	4	9.3	409	2.5	0.53
eddy pool	0	0.0	0	0.0	0.00
plunge pool	0	0.0	0	0.0	0.27
scour pool	6	13.9	1,585	9.8	0.68
scour hole	2	4.6	77	0.5	0.59
Beaver pond	0	0.0	0	0.0	
Total Pools	**12**	27.7	2,071	**12.8**	
Secondary channel	0	0.0	0	0	0.00
Grand Totals	**43**		**16,160**		

* (includes valley segment # 4)

(23.8%), residential, right of way (20.8%), agriculture (1 .1%) and wetland (0.9%). A mixed vegetative stand dominates the riparian area while the predominate seral stage is grass/forb (46.9%) followed by shrub (39.2%), mature (8.3%), young trees (1.8%) and pole (1.1 %). A mean canopy cover of 3.2% was calculated with a range of 0-99%. Six bank cutting sites were identified for a total length of 3,337 meters (Table 3.9). For the entire watershed 916 habitat units were classified comprising a total area of 10,4751 square meters (Table 3.10). Of the 916 habitat units, 77 (8.5%) were identified as cascades, 405 (44.2%) as riffles, and 430 (47.1 %) as pools.

For the lower reach of Benewah Creek, valley segments #1 and #2 were combined. Elevation began at 683 meters and rose to 732 meters in 3,776 meters. Mean stream gradient was 3.3% and a pool/riffle/cascade ratio of 1/14.5/2.8 was calculated (Table 3.11). Land use practices within the reach included forested (35.3%), residential and right of way (39.5%), livestock grazing (12.5%), mining (.06%) and wetland designation (0.8%). The vegetative type was comprised of deciduous, coniferous and mixed stands at 37.6%, 12.0% and 49.7%, respectively. The dominant seral stage was shrub (55.4%) followed by mature trees (21.5%), grass/forb (17.8%), pole (2.3%), young trees (2.0%), old growth forest (0.4%) and other (7.5%). Mean canopy cover was calculated at 4.9% with a range of 0 to 76%, Forty three logs and four root wads were counted in this section as woody debris.

A total of 169 habitat units for a total of 23,665 m^2 were enumerated and identified in the lower reach of Benewah Creek (Table 3.12). Twenty three (13.6%) were in the cascade category, 93 (55.1%) were in the riffle category, 52 (30.8%) were in the pool category and 1 (0.6) was identified as a secondary channel. In the cascade category, 10 (5.9%) were step pool cascades for a total area of 3,290 m^2, and 13 (7.7%) were slip face cascades for a total of 310 m^2. In the riffle category, 47 (27.8%) were identified as pocketwater for a total area of 2,045 m^2, 30 (17.8%) low gradient riffles for a total of 2,706 m^2, and 16 (9.5%) as glides for a total of 2,045 m^2. In the pool category 19 (11.2%) were identified as dammed pools for a total area of 553 m^2, 15 (8.9%) were scour holes for a total of 252 m^2, 12 (7.1%) were scour pools for a total of 377 m^2, 5 (3.0%) were plunge pools for a total area of 107 m^2, and one

Table 3.9. Summary report for the Benewah Creek Watershed, May-August, 1992.

Elevation	**683-853 m**
Total length	**19,605.8 m**
Stream order	**4**
Mean stream gradient	**2.1%**
Pool/riffle/cascade ratio	**1/14.5/2.8**
Land use	
Timber	23.8%
Agriculture	0.4%
Livestock grazing	54.0%
Mining	co.01 %
Wetland	0.9%
Other (includes residential,right of way, etc.)	20.a%
Vegetative type	
Deciduous	34.5%
Coniferous	4.5%
Mixed	61 .O%
Seral Stage	
Grass/forb	46.9%
Shrub	39.2%
Pole	1.1%
Young	1.8%
Mature	8.3%
Old growth	0.1 %
Other	2.5%
x Canopy cover	3.2 (O-99)
# Woody debris	
Logs	657
Root wads	33
Mass Wasting	**0.0**
Bank cutting	613337 **m**
Side Channels	**271975.2 m**

Table 3.10. **Frequency of occurrence, total percent occurrence, total area and percent area for habitat types on surveyed areas of the Benewah Creek drainage, May-August, 1992.**

Habitat Type	Frequency	% frequency	Total Area (sq. m)	% Area
Rapid	0	0.0	0	0
				3.4
Step pool cascade / Slip face cascade	61	6.7 / 1.8	3,509 / 2,496	2.4
Total Cascades	77	8.5	6,006	5.8
Pocketwater	85	9.3	26,979	25.8
Glide	89	9.7	13,441	12.8
Run	0	0.0	0	0.0
Low gradient riffle	231	25.2	25,019	23.9
Total Riffles	405	44.2	65,439	62.5
Dammed pool	50	5.5	5,236	5.0
Eddy pool	6	0.7	38	co.1
Plunge pool	8	0.9	175	0.2
Scour pool	287	31.3	16,977	16.2
Scour hole	62	6.8	852	0.8
Beaver pond	17	1.9	9,827	9.4
Total Pools	430	47.1	33,105	31.7
Secondary channel	4	0.4	201	0.2
Grand totals	**916**		**104751**	

Table 3.11. Summary report for the lower reach* of Benewah Creek, May-August, 1992.

Elevation	**683-732 m**
Total length	**3775.7 m**
Stream order	**4**
Mean stream gradient	**3.3%**
Pool/riffle/cascade ratio	**1/14.5/2.8**
Land use	
Timber	**35.3%**
Agriculture	
Livestock grazing	12.5%
Mining	0.6%
Wetland	0.8%
Other (includes residential,right of way, etc.)	39.5%
Vegetative type	
Deciduous	37.6%
Coniferous	12.8%
Mixed	49.7%
Seral Stage	
Grass/forb	17.a%
Shrub	55.4%
Pole	2.3%
Young	2.0%
Mature	21.5%
Old growth	0.4%
Other	7.5%
x Canopy cover	4.9 (O-76)
# Woody debris	
Logs	43
Root wads	4
Mass Wasting	0
Bank cutting	0
Side Channels	0

(*includes valley segments #1,#2)

Table 3.12. Frequency of occurrence, total percent occurrence, total area, percent area and residual pool depth values for the lower reach* of Benewah Creek, May-August, 1992.

Habitat Type	Frequency	% Frequency	Total Area (sq. m)	% Area	Residual pool depth (m)
Rapid	0	0.0	0	0.0	0
Step pool cascade	10	5.9	3,290	13.9	
Slip face cascade	13	7.7	310	1.3	
Totals Cascades	**23**	**13.6**	3,600	**15.2**	
Pocketwater	47	27.8	13,909	58.7	
Glide	16	9.5	2,045	8.6	
Run	0	0.0	0	0.0	
Low gradient riffle	30	17 8	2.706	11.4	
Total Riffles	**93**	55.1	18,660	78.7	
Dammed pool	19	11.2	553	2.3	0.55
Eddy pool	1	0.6	1.2	<0.1	0.08
Plunge pool	5	3.0	107	0.5	0.50
Scour pool	12	7.1	377	1.6	0.54
Scour hole	15	8.9	252	1.1	0.39
Beaver pond	0	0.0	0	0.0	
Total Pools	52	30.8	**1,290**	5.6	
Secondary channel	1	0.6	115	0.5	0.03
Grand Totals	**169**		23,665		

(*includes valley segments #1,#2)

(0.6%) was an eddy pool for a total of 1 m^2. Mean residual pool depths were calculated at 0.55 meters for the dammed pools, 0.08 meters for eddy pools, 0.5 meters for the plunge pools, 0.54 meters for the scour pools and 0.39 meters for the scour holes.

Valley segments #3 and # 4 were combined for the middle section of Benewah Creek. Elevation began at 732 meters and rose to 838 meters in 11,461 meters (Table 3.13). Mean stream gradient was calculated at 1.6 and a pool/riffle/cascade ratio of l/l .4/0.08 was calculated. Land use practices within the section included forested (20.1%), livestock grazing (61.5%), wetland designation (1.8%) and residential (16.7%). Vegetative type was primarily deciduous (65.3%) followed by mixed vegetation (32.3%) and coniferous (0.7%). Predominate seral stages included shrub (50.9%), and grass/forb (40.9%). The remaining 8.5% included some pole, young and mature stands. Mean canopy cover in this reach was 4.7% with a range of 0-99%. Four hundred fifty-seven logs and 17 root wads were enumerated within this section. Bank cutting occurred in six areas for a total length of 3,337 meters. Twenty seven side channels were enumerated within this reach for a total of 975 meters.

A total of 658 habitat units were enumerated and identified within the middle reach of Benewah Creek for a total of 73,286 m^2 (Table 3.14). Of the 658 units, 355 (54.1%) were in the pool category, 252 (38.3%) were in the riffle category and, 51 (7.8%) were in the cascade category. Of the fifty one in the cascade category, 48 (7.3%) were slip face cascades for a total area of 2,186 m^2, and three (0.5%) were step pool cascades for a total area of 207 m ? In the riffle category, 165 (25.2%) were low gradient riffles for a total area of 17,877 m^2, 49 (7.4%) were glides for a total area of 8,234 m^2, and 38 (5.8%) were pocketwater for a total area of 15,691 m^2. In the Pool category, 257 (39.1%) were scour pools for a total area of 15 601 m^2, 47 (7.1%) were scour holes for a total area of 600 m^2, 26 (4.0%) were dammed pools for a total area of 2,959 m^2, 17 (2.6%) were beaver ponds for a total area of 9,827 m^2, five (0.8%) were eddy pools for a total area of 37 m^2, and three (0.5%) were plunge pools for a total area of 67 m? Calculated mean residual pool depths were 0.51 meters for dammed pools, 0.14 meters for eddy pools, 0.51 meters for plunge pools, 0.45 meters for scour pools, 0.27 meters for scour holes and 0.56 meters for beaver ponds.

The upper reach of Benewah Creek consisted of valley segment

Table 3.13. Summary report for the middle reach* of Benewah Creek, May-August, 1992.

Elevation	**732-838 m**
Total length	**11,461.1 m**
Stream order	**4**
Mean stream gradient	**1.6%**
Pool/riffle/cascade ratio	**1/1.4/0.08**
Land use	
Timber	20.1%
Agriculture	
Livestock grazing	61.5%
Mining	
Wetland	1.8%
Other (includes residential,right of way, etc.)	16.7%
Vegetative type	
Deciduous	65.3%
Coniferous	0.7%
Mixed	32.3%
Seral Stage	
Grass/forb	40.9%
Shrub	50.9%
Pole	1.0%
Young	3.5%
Mature	3.7%
Old growth	
Other	
x Canopy cover	4.7% (O-99)
# Woody debris	
Logs	457
Root wads	17
Mass Wasting	
Bank cutting	613337 m
Side Channels	**271975.2 m**

(“includes valley segments #3,#4)

Table 3.14. Frequency of occurrence, total percent occurrence, total area, percent area and residual pool depth values for the middle reach* of Benewah Creek, May-August, 1992.

Habitat Type	Frequency	% Frequency	Total Area (sq. m)	% Area	Residual pool depth (m)
Rapid	0	0.0	0	0.0	
Step pool cascade	3	0.5	207	0.3	
Slip face cascade	48	7.3	2,186	3.0	
Totals Cascades	**51**	7.8	2,393	3.3	
Pocketwater	38	5.8	15,691	21.4	
Glide	49	7.4	8,234	11.2	
Run	0	0.0	0	0.0	
Low gradient riffle	165	25 1	17,877	24 4	
Total Riffles	252	38.3	41,802	57.0	
Dammed pool	26	4.0	2,959	4.0	0.51
Eddy pool	5	0.8	37	0.1	0.14
Plunge pool	3	0.5	67	0.1	0.51
Scour pool	257	39.1	15,601	21.3	0.45
Scour hole	47	7.1	600	0.8	0.27
Beaver pond	17	2.6	9,827	13 4	0.56
Total Pools	355	54.1	**29,091**	39.7	
Secondary channel	0	0.0	0	0.0	0
Grand Totals	658	**100.2**	73,286		

(*includes valley segments #3,#4)

#5. Elevation began at 838 meters and rose to 853 meters in 4,369 meters. A mean stream gradient of 1.5 was calculated. A pool/riffle/cascade ratio of .002/.006/1 was calculated. Land use within this reach consisted of livestock grazing (76.7%), forest (15.9%), residential (6.6%), and agriculture (1.1 %).

One hundred percent of the surveyed area was a mixed stand in which 83.5% was grass/forb with the remaining 12.5% shrub. No canopy cover existed in this reach. One hundred fifty seven logs and 12 root wads were enumerated (Table 3.15).

A total of 88 habitat units were identified for the upper reach of Benewah Creek. Of those 88, three (5.4%) were in the cascade category, 60 (68.2%) were in the riffle category, and 22 (25.1%) were in the pool category. In the cascade category all three units were identified as step pool cascades for a total area of 12 m? In the riffle category 36 (40.9%) were low gradient riffles for a total area of 4,437 m^2, and 24 (27.3%) were glides for a total area of **3,162** m^2. In the pool category 18 (20.5%) were scour pools for a total area of 1,001 m^2, and four (4.6%) were dammed pools for a total area of 1,723 m^2. Calculated residual pool depths were 1.3 meters for the dammed pools and 0.7 for the scour pools (Table 3.16).

3.1.1.4. **Evans Creek**

Five valley segments were surveyed for Evans Creek totaling 5,843 meters. Surveyed sections of the Evans Creek drainage ranged in elevation from 646 to 759 meters. Stream order ranged from one to four and had an average stream gradient of 2.2 Primary land uses practices in the watershed included forested (77.7%) and livestock grazing (22.3%) (Table 3.17). A mixed vegetative type was most abundant at 81 .O% and a strictly deciduous stand made up the remaining vegetation at 19%. The seral stage included mature stands at 77.3%, followed by grass/forb (18.9%), old growth (2.7%) and shrub (0.9%).

For the entire watershed 294 habitat units were classified (Table 3.18) comprising a total area of 25,521 square meters. Of the 294 habitat units, 72 (24.5%) were identified as cascades, 85 (28.9%) as riffles, as 137 (46.7%) as pools.

Table 3.15. Summary report for the upper reach of Benewah Creek, May-August, 1992.

Elevation	838-853 m
Total length	4369 m
Stream order	4
Mean stream gradient	1.5%
Pool/riffle/cascade ratio	.002/.006/l
Land use	
Timber	15.9%
Agriculture	1.1%
Livestock grazing	76.7%
Mining	
Wetland	
Other (includes residential,right of way, etc.)	6.3%
Vegetative type	
Deciduous	
Coniferous	
Mixed	100.0%
Seral Stage	
Grass/forb	83.5%
Shrub	12.5%
Pole	
Young	
Mature	
Old growth	
Other	
x Canopy cover	0.0 (O-0.00)
# Woody debris	
Logs	157
Root wads	12
Mass Wasting	0
Bank cutting	0
Side Channels	0

* (includes valley segment #5)

Table 3.16. Frequency of occurrence, total percent occurrence, total area, percent area and residual pool depth values for the upper reach* of Benewah Creek, May-August, 1992.

Habitat Type	Frequency	% Frequency	Total Area (sq. m)	% Area	Residual pool depth (m)
Rapid	0	0.0	0	0.0	
Step pool cascade	3	3.4	12	0.1	
Slip face cascade	0	0.0	0	00.	
Totals Cascades	**3**	5.4	12	**0.1**	
Pocketwater	0	0.0	0	0.0	
Glide	24	27.3	3,162	30.3	
Run	0	0.0	0	0.0	
Low gradient riffle	36	40 9	4,437	42 6	
Total Riffles	**60**	68.2	7,599	72.9	
Dammed pool	4	4.5	1,724	16.5	1.28
Eddy pool	0	0.0	0	0.0	0.00
Plunge pool	0	0.0	0	0.0	0.00
Scour pool	18	20.4	1,001	9.6	0.66
Scour hole	0	0.0	0	0.0	0.00
Beaver pond	0	0.0	0	0.0	0.00
Total Pools	22	25.1	2,725	26.1	
Secondary channel	3	3.4	86	0.8	0.13
Grand Totals	**88**		**10,421**		

* (includes valley segment #5)

Table 3.17. Summary report for the Evans Creek Watershed, May-August, 1992.

Elevation	**646-759 m**
Total length	5,843 **m**
Stream order	**4**
Mean stream gradient	2.2% **(1.5%-3.0%)**
Pool/riffle/cascade ratio	**1/3.4/2.29**
Land use	
Timber	77.7%
Agriculture	
Livestock grazing	22.3
Mining	
Other (includes residential etc.)	
Vegetative type	
Deciduous	19.0
Coniferous	
Mixed	81 .o
Seral Stage	
Grass/forb	18.9
Shrub	0.9
Pole	
Young	77.3
Mature	
Old growth	2.7
Other	
x Canopy cover	**59.2 (O-93)**
# Woody debris	
Logs	**136**
Root wads	13
Mass Wasting	**1800 m**

Table 3.18. Frequency of occurrence, total percent occurrence, total area and percent area for habitat types on surveyed areas Evans Creek, May-August,1992.

Habitat type	Frequency	% Frequency	Total Area (sq. m)	% Area
Rapid (RPD)	58	19.7	8,051	31.6
Step-pool cascade (SPC)	10	3.4	525	2.1
Slip-face cascade (SFC)	4	1.4	161	0.6
Total Cascades	72	24.5	8,737	34.3
Pocketwater (PKW)	0	0.0	0	0.0
Glide (GLD)	2	0.7	142	0.5
Run (RUN)	0	0.0		0.0
Low gradient riffle (LGR)	83	28.2	12.0837	50.3
Total Riffles	85	28.9	**12,979**	50.8
Dammed Pool (DMP)	9	3.1	262	1.0
Eddy pool (EDP)	9	3.1	166	0.6
Plunge pool (PLP)	25	8.5	481	1.9
Scour pool (SCP)	87	29.6	2,791	10.9
Scour hole (SCH)	7	2.4	104	0.4
Beaver pond (BVP)	0	0.0	0	0.0
Total Pools	137	46.7	3,805	14.8
Secondary channel (SDC)	0	0.0	0	0.0
Grand Totals	**294**		**25,521**	

In the lower reach of Evans Creek, only valley segment #1 was used. Elevation began at 646 meters and rose to 658 meters in 1,808.3 meters (Table 3.19). Mean stream gradient was 2.0% and a pool/riffle/cascade ratio of 13/77/1 was calculated. Land use practices within this section were 100% livestock grazing. The predominate vegetation was grass/forb at 94.8% and shrub at 4.3%. Mean canopy cover was 32.9% with a range of 0-72%. Sixteen logs and 8 root wads were identified in this reach. One thousand eight hundred meters of bank cutting were identified within this reach.

Fifty-eight habitat units were identified and counted within this section for a total of 8,931 m^2. Of the 58 units, two (3.5%) were in the cascade category, 27 (46.6%) were in the riffle category, and 29 (50.1%) were in the pool category. Both units in the cascade category were slip-face cascades for a total of 97 m? Twenty-five (46.6%) of the 27 units in the riffle category were low gradient riffles for a total, area of 7,364 m^2, and two (3.5%) were glides for a total area of 142 m^2. In the pool category, 19 (32.8%) were scour pools for a total area of 1,083 m^2, 5 (8.6%) were eddy pools for a total area of 144 m^2, three (5.2%) were scour holes for a total area of 52 m^2 and two (3.5%) were dammed pools for a total area of 42.3 m^2 (Table 3.20). Mean residual pool depths were calculated at 0.26 m, 0.68 m, 0.59 m and 0.43 meters for dammed, eddy, scour pools and scour holes, respectively.

Valley segment #2 comprised the middle reach of Evans Creek. Elevation began at 658 meters and rose to 695 meters in 832.1 meters (Table 3.21). Average stream gradient was 1.5% and a pool/riffle/cascade ratio of 4/17/1 was calculated. Land use was 100% forested. Vegetation consisted of 98.4% mature growth and 1.6% old growth. Mean canopy cover was 61% with a range of 0-93%. Fifty-eight logs and three root wads were counted within the reach

Sixty-four habitat units were counted and identified within the middle reach of Evans Creek for a total of 3,299 m^2 (Table 3.22). Seven (11 .0%) were in the cascade category, 31 (48.4%) were in the riffle category and 26 (40.6%) were in the pool category. Of the seven units in the cascade category, four (6.3%) were rapids for a total area of 72 m^2, two (3.1 %) were slip-face cascades for a total area of 64 m^2 and one (1.6%) was a step-pool cascade for an area of 8 m^2. All units (31/48.4%) in the riffle category were low gradient

Table 3.19. Summary report for lower reach of Evans Creek, May-August, 1992.

Elevation	**646-658 m**
Total length	**1808.3 m**
Stream order	**4**
Mean stream gradient	**2.0%**
Pool/riffle/cascade ratio	**13/77/1**
Land use	
Timber	
Agriculture	
Livestock grazing	100.0%
Mining	
Other (includes residential etc.)	
Vegetative type	
Deciduous	94.8%
Coniferous	
Mixed	5.2%
Seral Stage	
Grass/forb	95.7%
Shrub	4.3%
Pole	
Young	
Mature	
Old growth	
Other	
x Canopy cover	32.9 (O-72)
# Woody debris	
Logs	16
Root wads	8
Bank cutting	**1800 m**

* (includes only valley segment #1)

Table 3.20. Frequency of occurrence, total percent occurrence, total area, percent area, and residual pool depth values for the lower reach* of Evans Creek during 1992.

Habitat Type	Frequency	% Frequency	Total area (sq. m)	% total	Residual pool depth (m)
Rapid (RPD)	0	0.0	0	0.0	
Step-pool cascade	0	0.0	0	0.0	
Slip-face cascade	2	3.5	97	1.1	
Total Cascades	**2**	3.5	97	**1.1**	
Pocketwater	0	0.0	0	0.0	
Glide (GLD)	2	3.5	141	1.6	
Run (RUN)	0	0.0	0	0.0	
Low gradient riffle	25	43 1	7,365	82 5	
Total Riffles	**27**	46.6	7,506	84.1	
Dammed Pool (DMP)	2	3.5	42	0.5	0.26
Eddy pool (EDP)	5	8.6	144	1.6	0.68
Plunge pool (PLP)	0	0.0	0	0.0	0.00
Scour pool (SCP)	19	32.8	1,089	12.2	0.59
Scour hole (SCH)	3	5.2	52	0.6	0.43
Beaver pond (BVP)	0	0.0	0	0.0	0.00
Total Pools	**29**	**50.1**	**1,328**	**14.9**	

* (includes only valley segment #1)

Table 3.21. Summary report for the middle reach of Evans Creek, May-August, 1992.

Elevation	**658-695 m**
Total length	**832 m**
Stream order	**4**
Mean stream gradient	**1.5%**
Pool/riffle/cascade ratio	**4/17/1**
Land use	
Timber	100.0%
Agriculture	
Livestock grazing	
Mining	
Other (includes residential etc.)	
Vegetative type	
Deciduous	
Coniferous	
Mixed	100.0%
Seral Stage	
Grass/forb	
Shrub	
Pole	
Young	
Mature	98.4
Old growth	1.6
Other	
x Canopy cover	**61 (O-93)**
# Woody debris	
Logs	**58**
Root wads	**3**
Mass Wasting	**0**

Table 3.22. **Frequency of occurrence, total percent occurrence, total area, percent area, and residual pool depth values for the middle reach* of Evans Creek, May-August, 1992.**

Habitat Type	Frequency	% Frequency	Total area (sq. m)	% total	Residual pool depth (m)
Rapid (RPD)	4	6.3	72	2.2	
Step-pool cascade	1	1.6	8	0.2	
Slip-face cascade	2	3.1	64	1.9	
Total Cascades	**7**	**11.0**	**144**	4.3	
Pocketwater (PKW)	0	0.0	0	0.0	
Glide (GLD)	0	0.0	0	0.0	
Run (RUN)	0	0.0	0	0.0	
Low gradient riffle	31	48 4	2 533	76.8	
Total Riffles	**3 1**	48.4	2,533	76.8	
Dammed Pool (DMP)	2	3.1	26	0.8	0.20
Eddy pool (EDP)	0	0.0	0	0.0	0.68
Plunge pool (PLP)	3	4.7	42	1.3	0.34
Scour pool (SCP)	18	28.1	510	15.5	0.39
Scour hole (SCH)	3	4.7	43	1.3	0.22
Beaver pond (BVP)	0	0.0	0	0.0	0.00
Total Pools	26	40.6	621	**18.9**	
Sec. channel (SDC)	0	0.0	0	0	0.00
Grand Totals	**6 4**		**3,299**		

riffles for a total area of 2,533 m^2. Eighteen (28.1%) of the pools were classified as scour pools for a total of 510 m^2, while plunge pools and scour holes both accounted for three each units (4.7%) for total areas of 42m^2 and 43 m^2, respectively. The remaining two (3.1%) units were classified as dammed pools for a total area of **26.5** m^2. Calculated mean residual pool depths were 0.26, 0.68, 0.59, and 0.43 meters for dammed, eddy, scour pools and scour holes, respectively.

In the upper reach of Evans Creek, valley segments #3 and #4 were combined. Elevation began at 695 meters and rose to 756 meters in 2,859.1 meters (Table 3.23). Mean stream gradient was 2.7% and a calculated pool/riffle/cascade ratio of l/303/3.9 was calculated. Major land use practices within the watershed were forest (97.4%) and livestock grazing (2.6%) . The majority of the riparian area was mature forest stands (97.1%) and old growth (2.7%). Mean canopy cover was 65.6% with a range of 38-88%. Forty-eight logs for large organic debris were counted within this section.

One hundred fifty-six habitat units were identified within the upper reach for a total area of 11,460 m^2 (Table 3.24). Of the 158 units, 52 (33.3%) were cascades, 26 (16.7%) were riffles and 78 **(50.0%)** were pools. Within the cascade category, 46 (29.5%) were rapids for a total of 6,450 m^2. Six (3.8%) were step-pool cascades for a total area of 372 m^2. In the riffle category, all twenty-six (16.7%) were low gradient riffles for a total area of 2,877 m? Of the 78 pools, 48 (30.8%) were scour pools for a total area of 1,134 m ^{2}, 20 (12.8%) were plunge pools for a total area of 405 m^2, five (3.2%) were dammed pools for a total area of 193 m^2, four (2.6%) were eddy pools for a total area of 21 m2 and one (0.6%) was a scour hole for a total area of 9 m^2. Calculated mean residual pool depths were 0.45, 0.19, 0.43, 0.40, and 0.18 meters for dammed pools, eddy pools, plunge pools, scour pools and scour holes, respectively.

3.1.1.5. **Alder Creek**

Four valley segments were surveyed for the Alder Creek drainage totaling 5,843 meters. Average stream gradient was 2.2% (Table 3.25). Major land uses within the riparian area was 81.5% forested, 10.3% livestock grazing, and 8.2% residential. A mixed vegetative type was most abundant at 57.6% followed by a deciduous

Table 3.23. Summary report for the upper reach of Evans Creek, May-August, 1992.

Elevation	**695-756 m**
Total length	**2859 m**
Stream order	**4**
Mean stream gradient	**2.7%**
Pool/riffle/cascade ratio	**1/3.3/3.9**
Land use	
Timber	97.4%
Agriculture	
Livestock grazing	2.6%
Mining	
Other (includes residential etc.)	
Vegetative type	
Deciduous	
Coniferous	0.7
Mixed	99.3%
Seral Stage	
Grass/forb	
Shrub	
Pole	
Young	
Mature	97.1
Old growth	2.7
Other	
x Canopy cover	65.6 (38-88)
# Woody debris	
Logs	48
Root wads	0
Mass Wasting	**0**

. (includes valley segment #3 and #4)

Table 3.24. Frequency of occurrence, total percent occurrence, total area, percent area,and residual pool depth values for the upper reach* of Evans Creek, May-August, 1992.

Habitat Type	Frequency	% Frequency	Total area (sq. m)	% total	Residual pool depth (m)
Rapid (RPD)	46	29.5	6450	56.3	
Step-pool cascade	6	3.8	371	3.2	
Slip-face cascade	Q	0.0	Q	0.0	
Total Cascade	**52**	33.3	6,821	59.5	
Pocketwater (PKW)	0	0.0	0	0.0	
Glide (GLD)	0	0.0	0	0.0	
Run (RUN)	0	0.0	0	0.0	
Low gradient riffle	26	16.7	2,877	25.1	
Total Riffles	**26**	**16.7**	2,877	25.1	
Dammed Pool (DMP)	5	3.2	193	1.7	0.45
Eddy pool (EDP)	4	2.6	21	0.2	0.19
Plunge pool (PLP)	20	12.8	405	3.5	0.43
Scour pool (SCP)	48	30.8	1,134	9.9	0.40
Scour hole (SCH)	1	0.6	9	0.1	0.18
Beaver pond (BVP)	Q	0.0	0	0.0	0.00
Total **Pools**	78	50.0	**1.762**	**15.4**	
Sec channel (SDC)	0	0.0	0	0.0	0.00
Grand Totals	**156**		**11,461**		

* (includes vailey segment #3 and #4)

Table 3.25. Summary report for the Alder Creek Watershed, May-August, 1992.

Elevation	**740-902 m**
Total length	**'11,810 m**
Stream order	**3**
Mean stream gradient	2.7% **(2.3%-3.0%)**
Pool/riffle/cascade ratio	
Land use	
Timber	81.5%
Agriculture	
Livestock grazing	10.3%
Mining	
Wetland	
Other (includes residential, right of way, etc.)	8.2%
Vegetative type	
Deciduous	29.8%
Coniferous	12.6%
Mixed	57.6%
Serai Stage	
Grass/forb	**15.3%**
Shrub	52.0%
Pole	0.8%
Young	**19.9%**
Mature	12.1%
Old growth	
Other	
x Canopy cover	34.4% (O-99)
# Woody debris	
Logs	297
Root wads	48
Mass Wasting	

stand at 29.8% and a coniferous stand at 12.6%. Predominate seral stage was 52% shrub, 19.9% young forest, 15.3% grass/forb, 12.1% mature forest and 0.8% pole trees. Mean canopy cover was 34.4% with a range of 0-99%. Two hundred ninety-seven logs and forty eight root wads were identified within the stream channel.

A total of 606 habitat units for a total of 125,325 m^2 were identified and counted in Alder Creek. Of the 606 units, 35 (5.8%) were cascades, 424 (69.9%) were riffles,- 142 (23.5%) were pools and 5 (0.8%) were side channels (Table 3.26).

Valley segments #1 and #2 were combined and comprised the lower reach of Alder Creek. Elevation of the lower reach began at 704 meters and rose to 817 meters in 3,313.8 meters. Mean stream gradient was 2.8% and a pool/riffle/cascade ratio of 4.8/1/.03 was calculated. Primary land use within the riparian area was 99.6% forest and .04% other. A mixed deciduous and coniferous vegetative type was the most abundant (59.9%), followed by a strictly coniferous stand (34.6%), and a deciduous stand (5.6%). Primary seral stage was young trees (40.7%) followed by shrub (35.1%), mature forest (14.6%), grass/forb (8.4%) and pole (1.2%). Mean canopy cover was 30.0% with a range of 0-99%. One hundred forty-eight logs, and 17 root wads were identified within this reach for large organic debris (Table 3.27).

Two hundred twenty two units were identified in the lower reach of Alder Creek for a total area of 85,018 m^2 (Table 3.28). Of the 222 units, 11 (5.1%) were cascades, 150 (67.6%) were riffles, 58 (23.5%) were pools and three (1.4%) were side channels. Of the eleven units in the cascade category, seven (3.2%) were step-pool cascades for a total area of 408 m^2, three (1.4%) were slip face cascades for a total area of 31 m^2, and one (0.5%) was a rapid for a total area of 29 m^2. Of the 150 riffle units, 74 (33.3%) were classified as low gradient riffles for a total area of 23,062 m^2, 47 (21.2%) were glides for a total area of 4,878 m^2, and 29 (13.1%) were pocketwater for a total area of 42,278 m? Thirty-three (14.9%) units in the pool category were identified as scour pools for a total area of 5,282 m^2. Eighteen (8.1%) were identified as plunge pools for a total area of 2,102 m^2, six (2.7%) were identified as dammed pools for a total area of 6,893 m^2 and one (0.5%) was identified as a scour hole for a total area of 55 m^2. Three (1.4%) side channels were identified in this reach for a total area of 366 m^2. Average residual pool depths were 0.42 meters for dammed

Table 3.26. Frequency of occurrence, total percent occurrence, total area and percent area for the Alder Creek drainage, May-August, 1992.

Habitat Type	Frequency	% Frequency	Total Area (sq. m)	% Area
Rapid	1	0.2	29	<0.1
Step pool cascade	9	1.5	417	0.3
Slip face cascade	25	4.1	352	0.3
Total Cascades	35	5.8	798	0.7
Pocketwater	39	6.4	42,948	34.3
Glide	165	27.2	15,471	12.3
Run	0	0.0	0	0.0
Low gradient riffle	220	36.3	42.059	33 6
Total Riffles	424	**69.9**	100,478	80.2
Dammed pool	29	4.8	12,020	9.6
Eddy pool	0	0.0	0	0.0
Plunge pool	21	3.5	2,279	1.8
Scour pool	91	15.0	9,044	7.2
Scour hole	1	0.2	55	co.1
Beaver pond	0	0.0	0	0.0
Total Pools	**142**	23.5	23,398	**18.7**
Secondary channel	5	0.8	653	0.52
Grand totals	606		**12,5327**	

Table 3.27 Summary report for the lower reach* of Alder Creek, May-August, 1992.

Elevation	704-817 m
Total length	3313.8m
Stream order	3
Mean stream gradient	2.8%
Pool/riffle/cascade ratio	4.8/1/.03
Land use	
Timber	99.6%
Agriculture	
Livestock grazing	
Mining	
Wetland	
Other (includes residential,right of way, etc.)	0.4%
Vegetative type	
Deciduous	5.6%
Coniferous	34.6%
Mixed	59.9%
Seral Stage	
Grass/forb	8.4%
Shrub	35.1%
Pole	1.2%
Young	40.7%
Mature	14.6%
Old growth	
Other	
x Canopy cover	30.0 (O-99)
# Woody debris	
Logs	148
Root wads	17
Mass Wasting	

* (includes valley segments #1 and #2)

Table 3.28. Frequency of occurrence, total percent occurrence, total area, percents area, and residual pool depth for the lower reach* of Alder Creek, May-August, 1992.

Habitat Type	Frequency	% Frequency	Total Area (sq. m)	% Area	Residual pool depth (m)
Rapid	1	0.5	29	<0.1	
Step pool cascade	7	3.2	408	0.5	
Slip face cascade	3	1.4	31	<0.1	
Total Cascades	**11**	**51**	**469**	0.7	
Pocketwater	29	13.1	42,278	52.5	
Glide	47	21.2	4,878	6.1	
Run	0	0.0	0	0.0	
Low gradient riffle	74	33 3	23,062	28.6	
Total Riffles	**150**	67.6	**70,218**	87.2	
Dammed pool	6	2.7	6,893	8.6	0.42
Eddy pool	0	0.0	0	0.0	
Plunge pool	18	8.1	2,102	2.6	0.69
Scour pool	33	14.9	5,282	6.6	0.47
Scour hole	1	0.5	55	0.7	0.08
Beaver pond	0	0.0	0	0.0	0.00
Total Pools	58	26.2	14,332	**18.5**	
Secondary channel	3	1.4	366	0.5	
Grand Totals	**222**		**85,018**		

• (includes valley segments #1 and #2)

pools, 0.69 meters for plunge pools, 0.47 meters for scour pools, and 0.08 meters for scour holes.

The middle reach of Alder Creek was comprised of valley segment #3. Elevation stayed constant at 817 meters in 961 meters. Mean stream gradient was 3.0% and a pool/riffle/cascade ratio of 2.7/71.2/1 was calculated (Table 3.29). Primary land use within the riparian area was 78.9% forest, 8.9% livestock grazing and 12.2% residential. A deciduous vegetative type was the most predominate (77.8%) while a mixed deciduous/coniferous mix made up the remaining 22.2%. Primary seral stage was 68.9% shrub followed by 26.7% grass/forb, 3.3% young trees and 1.1% pole trees. Mean canopy cover was 26.8% with a range of 0-95%. Two logs and one root wad were identified within this reach.

Forty-five habitat units were identified within this reach for a total area of 3,954 m^2. Of these units, three (6.6%) were in the cascade category, 40 (88.9%) were in the riffle category, and two (4.4%) were in the pool category (Table 3.30). Of the three cascade units, two (4.4%) were slip-face cascades for a total area of 49 m^2 and one (2.2%) was a step-pool cascade for a total area of 4 m? Of the forty riffle units, 21 (46.7%) were identified as glides for a total area of 1,361 m^2, and 19 (42.2%) were low gradient riffles for a total area of 2396 m? One plunge pool and scour pool were identified within the pool category for a total area of 126 m^2 and 19 m^2, respectively. Residual pool depths were calculated at 0.55 meters and 0.18 meters for plunge pools and scour pools, respectively.

Valley segment #4 comprised the upper section of Alder Creek. Elevation began at 817 meters and rose to 902 meters in 7,535 meters. Mean stream gradient was 2.3% with a pool/riffle/cascade ratio of 33/84/l (Table 3.31). Primary land use within the riparian area was 65.8% forested, 22.0% livestock grazing and 12.2% residential. A mixed coniferous/deciduous vegetative type existed in 90.9% of the area, while a deciduous stand existed in 6.0% and a coniferous stand existed in 3.1%. Primary seral stage was 51.9% shrub, followed by 15.6% young trees, 21.7% mature trees and 10.8% grass/forb. Mean canopy cover was 46.3%, with a range of 0-94%. One-hundred-forty-eight logs and thirty root wads were identified in the upper reach of Alder Creek.

Three-hundred-eighteen habitat units were identified with the upper reach of Alder Creek for a total area of 32,732 m^2. Of the 318

Table 3.29. Summary report for the middle reach* of Alder Creek, May-August, 1992.

Elevation	817-817 m
Total length	961 m
Stream order	3
Mean stream gradient	3.0%
Pool/riffle/cascade ratio	2.7171 .2/l
Land use	
Timber	78.9%
Agriculture	
Livestock grazing	8.9%
Mining	
Wetland	
Other (includes residential,right of way, etc.)	12.2%
Vegetative type	
Deciduous	77.8%
Coniferous	
Mixed	22.2%
Seral Stage	
Grass/forb	26.7%
Shrub	68.9%
Pole	1.1%
Young	3.3%
Mature	
Old growth	
Other	
x Canopy cover	26.8 (O-95)
# Woody debris	
Logs	2
Root wads	1
Mass Wasting	

. (includes valley segment #3)

Table 3.30. Frequency of occurrence, total percent occurrence, total area, percent area, and residual pool depth for the middle reach of Alder Creek, May-August, 1992.

Habitat Type	Frequency	% Frequency	Total Area (sq. m)	% Area	Residual pool depth (m)
Rapid	0	0.0	0	0.0	
Step pool cascade	1	2.2	4	0.0	
Slip face cascade	2	4.4	49	1.2	
Total Cascades	**3**	6.6	53	**1.2**	
Pocketwater	0	0.0	0	**0.0**	
Glide	21	46.7	1,361	34.4	
Run	0	0.0	0	0.0	
Low gradient riffle	19	42.2	2,396	60.6	
Total Riffles	**40**	88.9	3,757	95.0	
Dammed pool	0	0.0	0	0.0	0.00
Eddy pool	0	0.0	0	0.0	0.00
Plunge pool	1	2.2	126	3.2	0.55
Scour pool	1	2.2	19	0.5	0.18
Scour hole	0	0.0	0	0.0	0.00
Beaver pond	0	0.0	0	0.0	0.00
Total Pools	2	4.4	145	3.7	
Secondary channel	0	0.0	0	0.0	
Grand Totals	**45**		**3,954**		

Table 3.31. Summary report for the upper reach of Alder Creek, May-August, 1992.

Elevation	817-902 m
Total length	7,535 m
Stream order	3
Mean stream gradient	2.3
Pool/riffle/cascade ratio	33/84/1
Land use	
Timber	65.8%
Agriculture	
Livestock grazing	22.0%
Mining	
Wetland	
Other (includes residential,right of way, etc.)	12.2%
Vegetative type	
Deciduous	6.0%
Coniferous	3.1%
Mixed	90.9%
Seral Stage	
Grass/forb	10.8%
Shrub	51.9%
Pole	
Young	15.6%
Mature	21.7
Old growth	
Other	
x Canopy cover	46.3 (O-94)
# Woody debris	
Logs	147
Root wads	30
Mass Wasting	

units, 21 (6.6%) were in the cascade category, 214 (67.2%) were in the riffle category, 81 (25.4%) were in the pool category and two (0.6%) were side channels. Twenty (6.3%) of the units in the cascade category were classified as slip face cascades for a total area of 271 m^2 and one (0.3%) was a step-pool cascades for a total area of 6 m^2. Of the 214 riffle units, 118 (37.1%) were low gradient riffles for a total area of 14,100 m^2, 86 (27.0%) were glides for a total area of 8,510 m^2 and ten (3.1%) were pocketwater for a total area of 671 m^2. Out of 81 pool units, 57 (17.9%) were scour pools for a total area of 3,744 m^2, 23 (7.2%) were dammed pools for a total area of 5,126 m^2 and one (0.3%) was a plunge pool for a total area of 21 m? Two (0.6%) side channels were identified for a total area of **287** m? Mean residual pool depths were calculated at 0.57 meters for dammed pools, 0.30 meters for plunge pools and 0.50 meters for scour pools (Table 3.32).

Habitat was identified and counted for the headwaters of Alder Creek and the north fork of Alder Creek and can be found in Appendix B.

3.1.2. Stream Reach Index and Channel Stability Evaluation.

Stream reach index and channel stability evaluations were conducted on each stream reach during 1992. Streams were divided into reaches based on fish relative abundance and population data sites. An overall stream rating was determined as well as individual reach ratings. Raw numbers for each category for each stream reach can be found in Appendix C.

Fifty three percent of Lake Creek was surveyed (Table 3.33). An overall fair stream rating was determined from a stream value of 90. The lower reach of Lake Creek had a good value at 59 and the middle reach had a fair rating at 78. The upper reach of Lake Creek rated poor with a value of 128.

Sixty seven percent of Benewah Creek was surveyed for an overall fair stream rating of (89). The lower and upper sections received a fair stream rating with values of 80 and 106, respectively, while the middle section received a good stream rating at 74.

Table 3.32. Frequency of occurrence, total percent occurrence, total area, percent area, and residual pool depth for the upper reach of Aider Creek, May-August, 1992.

Habitat Type	Frequency	% Frequency	Total Area (sq. m)	% Area	Residual pool depth (m)
Rapid	0	0	0	0.0	
Step pool cascade	1	0.3	6	0.1	
Slip face cascade	20	6.3	271	0.8	
Total Cascades	**21**	6.6	271	0.9	
Pocketwater	10	3.1	671	2.1	
Glide	86	27.0	8,510	26.0	
Run	0	0.0	0	0.0	
Low gradient riffle	118	37 1	14.100	43 1	
Total Riffles	214	67.2	23,281	71.2	
Dammed pool	23	7.2	5,126	15.7	0.57
Eddy pool	0	0.0	0	0.0	0.00
Plunge pool	1	0.3	21	0.1	0.30
Scour pool	57	17.9	3,744	11.4	0.50
Scour hole	0	0.0	0	0.0	0.00
Beaver pond	0	0.0	0	0.0	0.00
Total Pools	**81**	25.4	**32,1**73	27.2	
Secondary channel	2	0.6	287	0.9	0.08
Grand Totals	**31 8**		**32,731**		

Table 3.33. Calculated stream reach and channel stability index (SRCSI) values for each stream segment sampled and the overall stream rating May - June, 1992.

Stream reach	SRCSI value (rating)	Reach length (km)	Overall stream rating
Benewah			
Lower	80 (fair)	4.4	
Middle	74 (good)	5.0	89
Upper	106 (fair)	6.8	**FAIR**
Area sampled (% of entire stream)		16.2 (67%)	
Evans			
Lower	138 (poor)	1.7	
Middle	77 (fair)	1.9	98
Upper	68 (good)	0.9	**FAIR**
Area sampled (% of entire stream)		4.5 (56%)	
Alder			
Lower	41 (good)	5.0	
Middle	46 (good)	3.1	48
Upper	59 (good)	3.9	**GOOD**
Area sampled (% of entire stream)		12.0 (60%)	
lake			
Lower	59 (good)	3.1	
Middle	78 (fair)	3.4	90
Upper	121 (poor)	4.3	**FAIR**
Area sampled (% of entire stream)		10.8 (53%)	

Fifty six percent of the Evans Creek Watershed was surveyed for an overall fair stream rating of 98. The lower section received a poor rating with a value of 138, the middle section received a fair rating (77) and the upper section received a good rating (68).

Sixty percent of the Alder Creek Watershed was surveyed for an overall good stream rating (48). All three sections of Alder received a good rating with values of 41, 46, and 59 for the lower, middle and upper segments, respectively.

3.1.3. Stream Discharge

Stream discharge measurements were collected monthly from February 6, 1992 through November 10, 1992. During the months of spring run off, March and April, discharge measurements were collected three and two times, respectively. Table 3.34. lists the monthly discharge measurements for all four creeks. Benewah Creek had a discharge of 30 cubic feet per second (cfs) in February followed by the yearly high flow of 39 cfs in the second week of March (Figure 3.1). The discharge declined each month following high flow from 32 cfs in March (20th) to the years lowest discharge of 1.0 cfs in August. September, October and November measurements increased to 3, 2 and 10 cfs, respectively.

Evans Creek discharges for the year were 21 cfs for February, 29, 19 and 17 cfs for March, 12 and 13 cfs for April, 5 cfs for May, 4 for June, 2 for July, 2 for August, 3 for September, 5 for October and 5 cfs for November (Figure 3.2). Early March was the highest discharge recorded and the lowest discharge was found in August.

Figure 3.3 shows the yearly discharge profile for Lake Creek. The highest recorded discharge was 32 cfs on March 13th, after this point the discharge declined to 22 cfs in late March and steadily decreased to 0.4 cfs through the month of August. Beginning in September discharge increased to 0.5 cfs followed by October, November and February with discharges of 3, 5 and 24 cfs, respectively.

Alder Creek discharges for the 1992 year were 21, 14 and 7 cfs for March, 5 and 6 cfs for April, 3 cfs for May, 3 for June, 1 for July and August, 4 for September, 8 for October and 13 cfs for November (Figure 3.4). The highest discharge was recorded in March and the lowest discharge was found in July and August

Table 3.34. Monthly discharge measurements in cubic feet per second (cfs) for selected Coeur d'Alene tributaries during 1992.

Month	Benewah	Alder	Lake	Evans
2/6/92	30.1	*	23.7	20.6
3/13/92	38.9	21.3	32.2	28.7
3/20/92	31.8	13.7	21.8	19.2
3/30/92	16.9	7.3	16.8	17.1
4/9/92	10.5	5.2	10.9	11.5
4/27/92	5.2	5.5	4.5	12.8
5/27/92	5.5	3.2	3.8	4.7
6/30/92	2.6	3.3	1.0	4.4
7/30/92	0.8	0.6	0.4	1.8
8/10/92	0.6	0.6	0.4	1.6
9/8/92	2.7	3.9	0.5	2.8
10/8/92	2.3	7.9	2.5	4.9
11/10/92	9.8	12.5	5.2	4.6

*site could not be accessed.

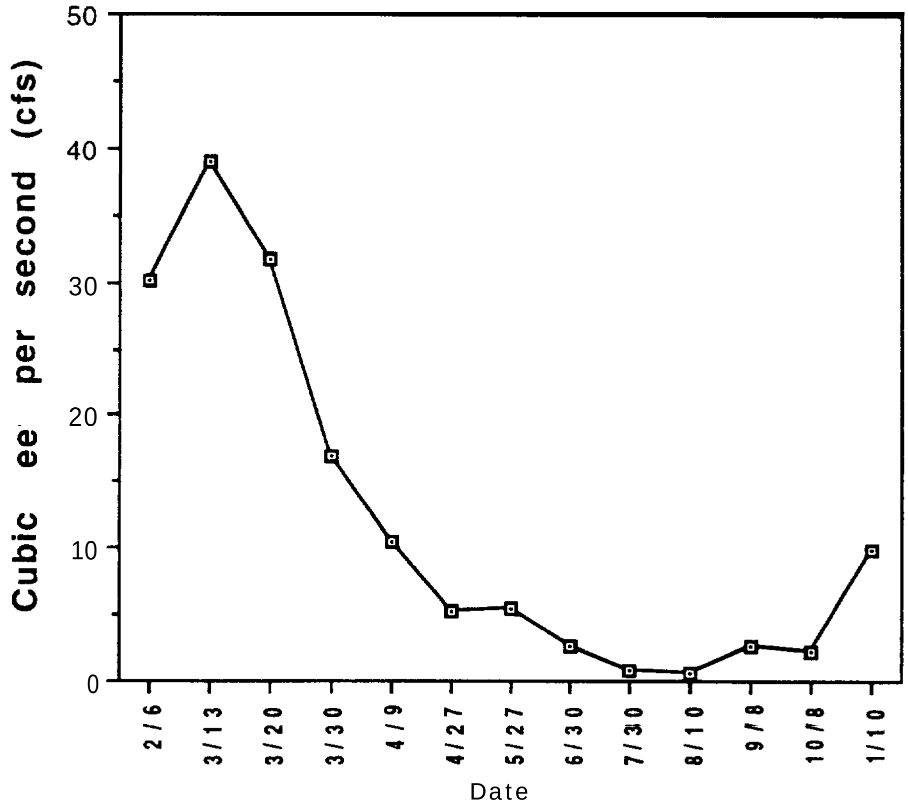


Figure 3.1. Monthly discharge measurements for Benewah Creek, February-November, 1992.

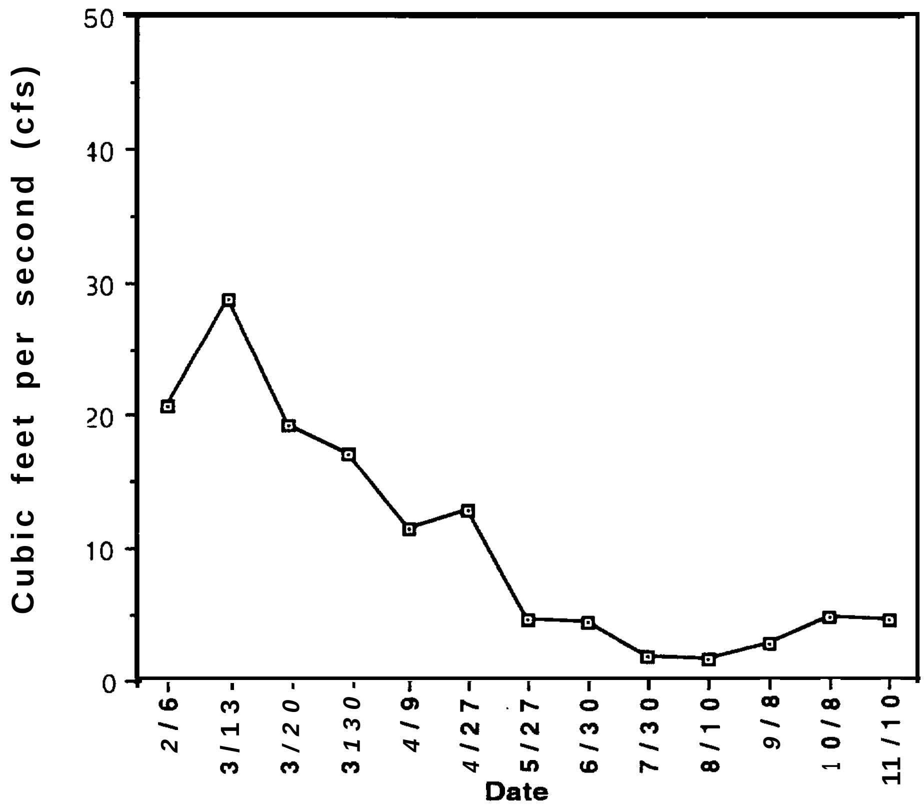


Figure 3.2. Monthly discarge profiles for Evans Creek, February-November, 1992.

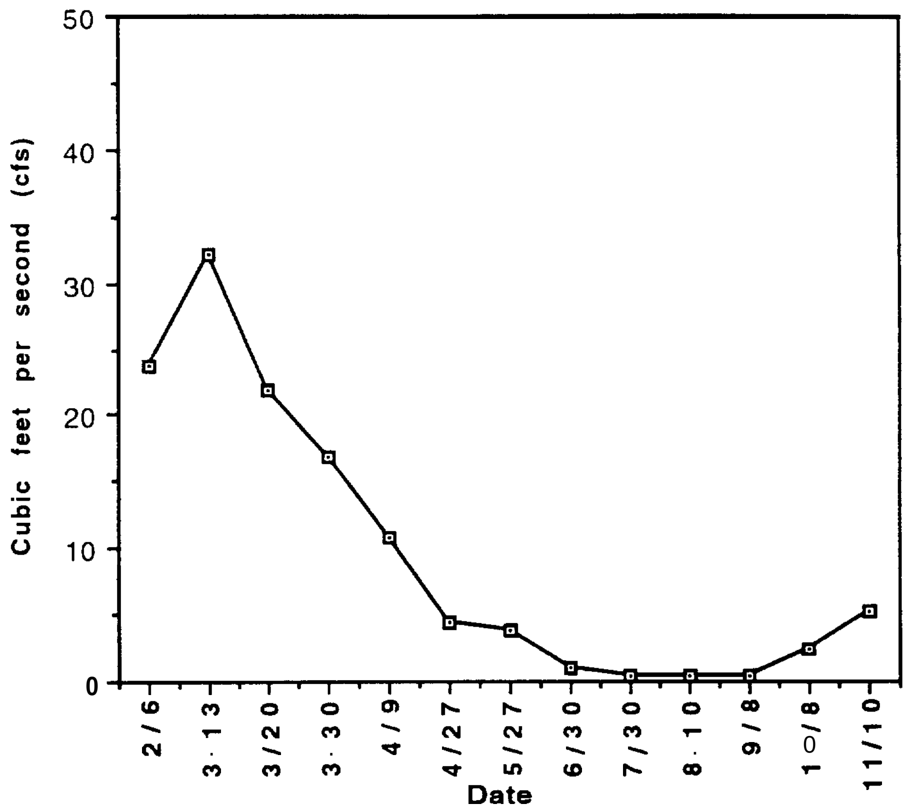


Figure 3.3. Monthly discharge profiles for Lake Creek, February-November, 1992.

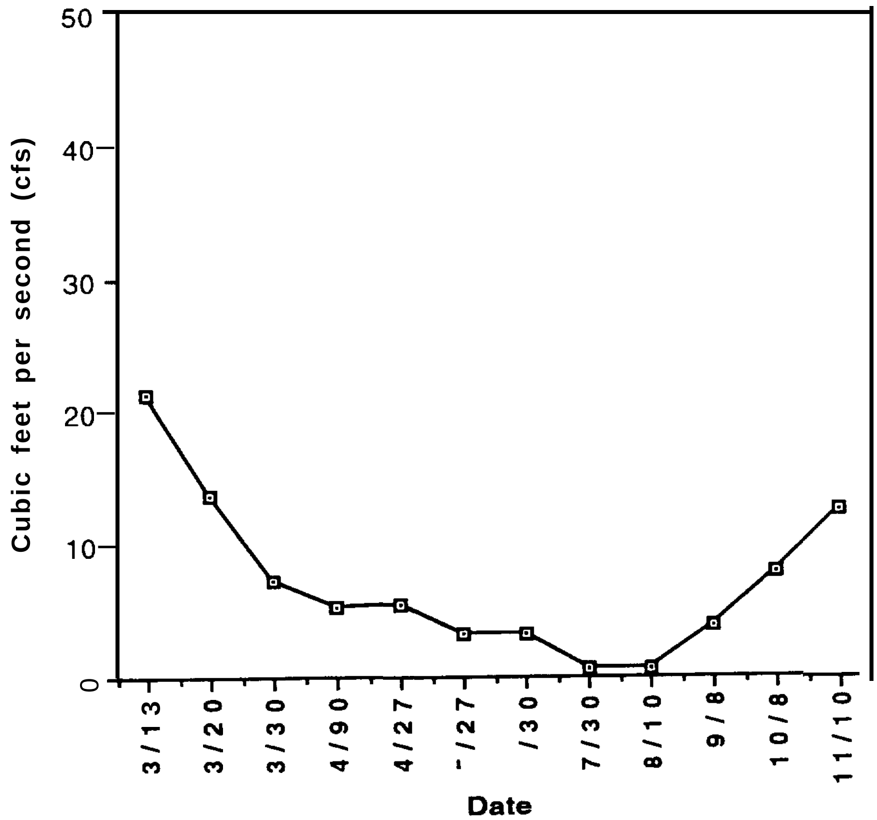


Figure 3.4. Monthly discharge profi es for Alder Creek, March-November, 1992.

3.1.4. **Stream Temperatures**

Monthly temperatures were collected at the four streams from February 6, 1992 to November 10, 1992. During the months of spring run off, March and April, temperatures were collected three and two times, respectively. Table 3.35 lists the monthly temperatures for all four creeks.

Benewah Creeks lowest temperature was 0° Celsius for the month of February. The temperatures steadily increased through the year to 4 °C, 7 °C, 4 °C, 5 °C, 13 °C, 12 °C, and 17 °C for March 13th, March 20th, March 30th, April 9th, April 27th, May, and July , respectively. The highest temperature was recorded in July at 17 °C, followed by a sharp decrease of 7 °C in October, and a gradual decrease to 4° C in November (Figure 3.5).

Evans Creeks temperatures for the year were 4 °C for February, 4 and 6 °C for March, 4 and 10 °C for April, 15 °C for May, 17 °C for July, 4 °C for September, 8 °C for October and 3 °C for November (Figure 3.6). The highest temperature was recorded in July and the lowest temperature was recorded in November.

The temperature profile for Lake Creek is shown in Figure 3.7 The lowest temperature of 1 °C was recorded in February. March temperatures were 6 and 4 °C, followed by April at 5, 12, and 10 °C, June at 25 °C, September at 4 °C, October at 11 °C and November at 3 °C. July had the highest monthly temperature of the year for Lake Creek.

Alder Creeks temperatures for the year were 3, 6 and 4 °C for March, 3 and 12 °C for April, 12 °C for May, 17 °C for July, 4 °C for September, 3 °C for October and 3 °C for November (Figure 3.8). The highest temperature was recorded in July and the lowest temperature was recorded in March.

3.1.5. Water Quality Analysis

Water quality data was analyzed seasonally for spring, summer and fall in April, August, and September, respectively for the four creeks. Spring alkalinity values ranged from 30 ppm in Evans Creek to 50 ppm in Benewah and Alder Creeks. Nitrite values ranged from .Ol ppm in Benewah, Evans, and Lake Creeks to .03 ppm in Alder

Table 3.35. Monthly temperature profiles (centigrade) for selected Coeur d'Alene tributaries during 1992.

Month	Benewah	Alder	Lake	Evans
2/6/92	0	*	1.0	4.0
3/13/92	4.4	2.8	5.6	4.4
3/20/92	6.7	5.6	3.9	3.9
3/30/92	4.4	4.4	4.4	6.1
4/9/92	5.0	3.0	5.0	4.0
4/27/92	13.0	12.0	12.0	10.0
5/27/92	12.0	12.0	10.0	15.0
6/30/92	•	*	*	*
7/30/92	17	17	25.0	17.0
8/10/92	*	*	*	•
9/8/92	6.6	4.4	4.4	4.4
10/8/92	5.6	3.3	11.0	a
11/10/92	4.4	3.3	2.8	2.8

*values were not collected.

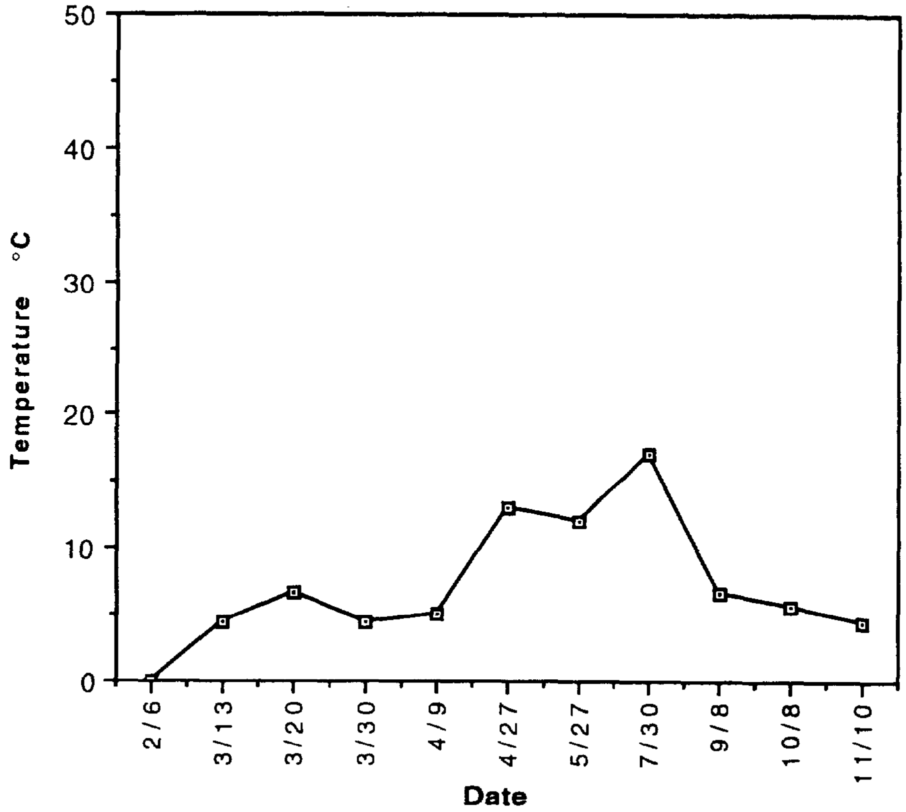


Figure 3.5. Temperature profiles for Benewah Creek, February-November, 1992.

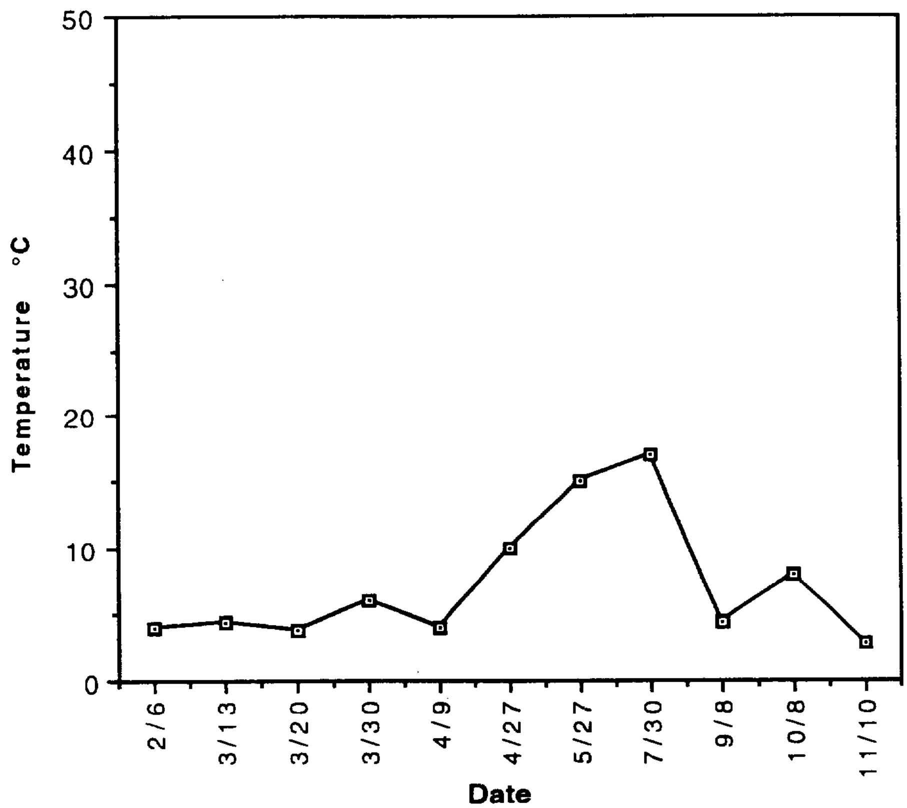


Figure 3.6. Temperature profiles for Evans Creek, February-November, 1992.

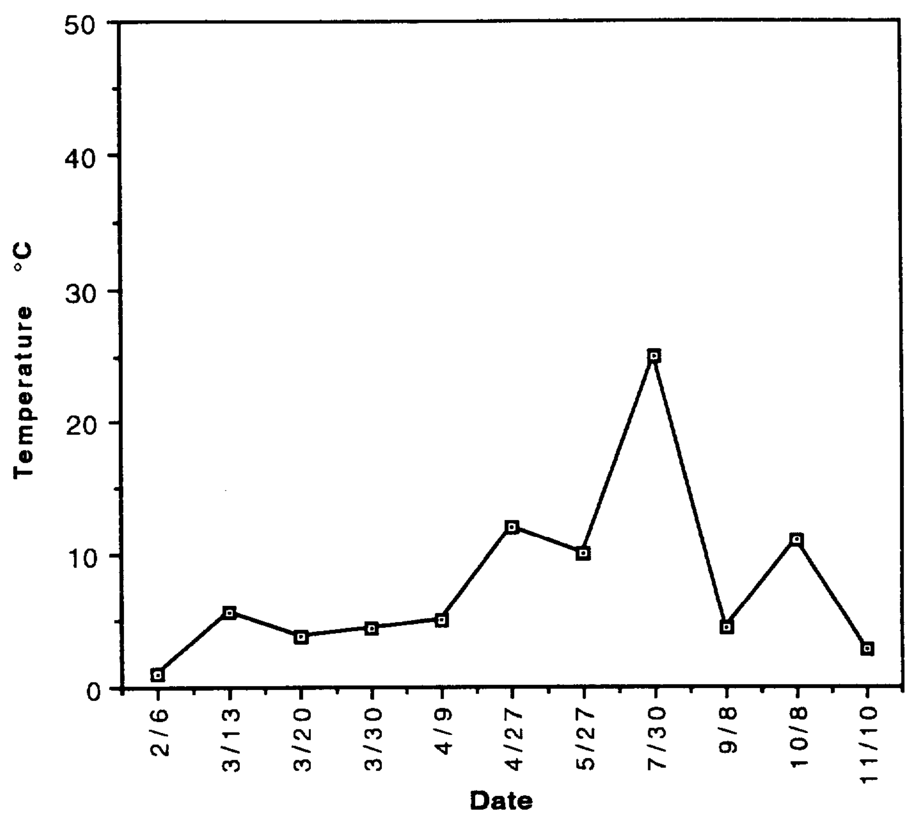


Figure 3.7. Temperature profiles for Lake Creek, February-November, 1992.

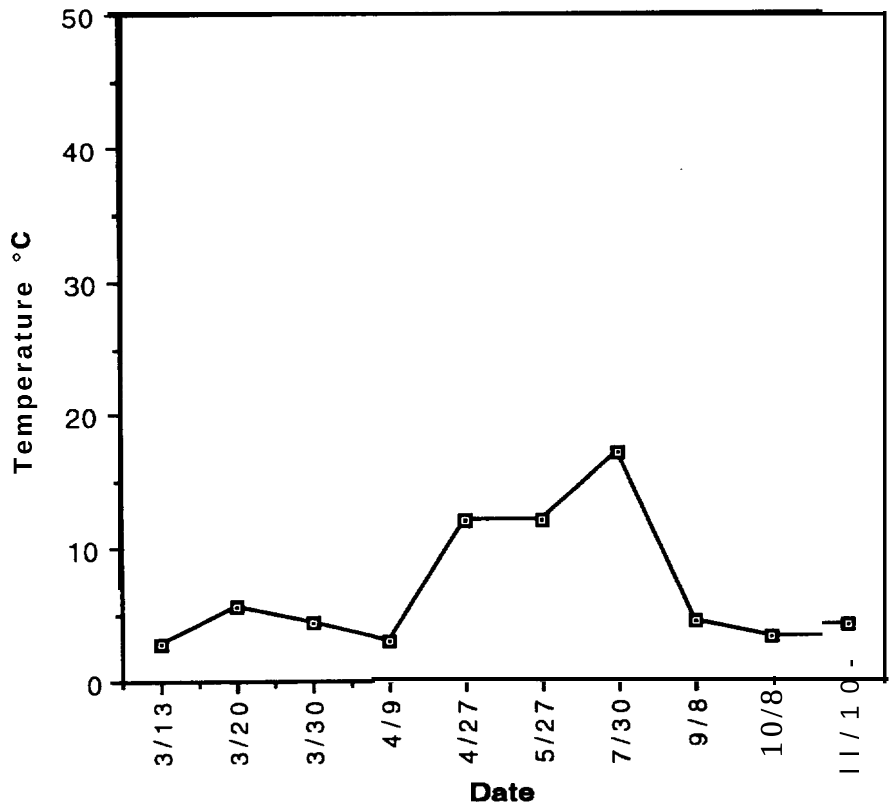


Figure 3.8. **Temperature profiles for Alder Creek, March-November, 992.**

Creek. Nitrate values ranged from 0 in Benewah, Evans and Alder Creeks to .09 in Lake Creek. Phosphate values ranged from .07 ppm in Lake Creek to 1.39 ppm in Alder Creek. Total dissolved solids (ppm) ranged from 10 in Evans Creek to 20 in the remaining three creeks. Turbidity values ranged from 12 Formazin Turbidity Units (FTU) in Evans Creek to 18 FTU in Lake and Alder Creeks (Table 3.36). PH values ranged from 6.0 in Evans to 7.3 in Alder Creek (Table 3.37).

Summer alkalinity values ranged from 40 ppm in Evans Creek to 65 ppm in Lake Creek. Nitrite values ranged from 0 in Alder Creek to .06 ppm in Benewah and Lake Creeks. Nitrate (ppm) values ranged from 0 in Evans Creek to .08 in Alder Creek. Phosphate values ranged from .18 ppm in Alder Creek to 1.06 ppm in Evans Creek (Table 3.36). PH values ranged from 5.0 in Lake Creek to 7.6 in Alder Creek. Dissolved oxygen (ppm) values ranged from 10.8 in Evans Creek to 12.2 in Lake Creek (Table 3.37).

Fall alkalinity values ranged from 40 ppm in Evans and Lake Creek to 80 ppm in Alder Creek. Nitrite values ranged from .Ol ppm in Alder Creek to .06 ppm in Benewah Creek. Nitrate values were 0 for all four creeks in the fall. Phosphate values ranged from .76 ppm in Benewah Creek to 1.06 ppm in Evans Creek (Table 3.36). PH values ranged from 7.1 in Evans and Lake Creeks to 7.4 in Benewah Creek (Table 3.37).

3.1.6. Fredle Index Values and Percent Cutthroat Trout Survival

A total of one hundred and fifty substrate samples were collected from four streams during 1992. Geometric means, sorting coefficients, fredle index values, and predicted % survival rates of cutthroat trout were calculated for each sample and can be found in Appendix D.

Mean fredle index values and percent survival can be found in Table 3.38. Mean fredle index values for Benewah Creek were 17.9, 18.9 and 4.5 for the lower, middle, and upper reaches, respectively. Mean fredle index values for Alder Creek were 7.9, 21.6, and 10.0 for the lower, middle and upper reaches, respectively. Evans Creek had fredle index values of 3.7, 6.8, and 7.4 for the lower, middle, and upper reaches respectively. Lake Creek had index values of 8.3, 8.7,

Table 3.36 Seasonal water quality parameters for selected Coeur d'Alene tributaries.

	SPRING						SUMMER				FALL			
	Alk. (ppm)	NO_2 (ppm)	NO_3 (ppm)	PO_4 (ppm)	TDS (ppm)	Turbidity (NTU)	Alk. (ppm)	NO;! (ppm)	NO_3 (ppm)	PO_4 (ppm)	Alk. (ppm)	NO_2 (ppm)	NO_3 (ppm)	PO_4 (ppm)
Benewah	50	.01	0	1.09	20	15	60	.06	.04	.58	50	.06	0	.76
Evans	30	.01	0	.36	10	12	40	.05	0	1.06	40	.04	0	1.06
Lake	45	.01	.09	.07	20	18	65	.06	.04	.44	40	.03	0	.91
Alder	50	.03	0	1.39	20	18	60	0	.08	.18	80	.01	0	.91

*Total dissolved solids and turbidity not determined.

Table 3.37 Seasonal hydrolab water quality parameters for selected Coeur d'Alene tributaries.

	SPRING		SUMMER		FALL*	
	pH	D.O. (ppm)	pH	D.O. (ppm)	pH	D.O. (ppm)
Benewah	6.3-7.3		5.0-7.3	11.9	7.4	-
Evans	6.0-6.3		6.5-7.3	10.8	7.1	
Lake	6.7		5.0-7.2	12.2	7.1	
Alder	7.0-7.3		6.4-7.6	11.6	7.2	

-data not collected

Table 3.38 Mean fredle index values and mean calculated percent survival values for cutthroat trout in selected stream reaches during 1992.

Stream	Fredle Index	% Survival
Bene wah		
Lower	17.9	**87.9**
Middle	18.9	**96.7**
Upper	4.5	67.4
Alder		
Lower	7.9	**90.6**
Middle	21.6	**97.5**
Upper	10.0	86.1
Evans		
Lower	3.7	**59.3**
Middle	***6.8***	78.6
Upper	***7.4***	83.1
Lake		
Lower	8.3	74.2
Middle	8.7	69.5
Upper	10.7	54.0
Bozard	1.1	19.3
West Lake Creek	0.4	5.4
Upper Lake Creek'	***0.1***	0.0

'upstream of where forks of Lake Creek merge and 10.7 for the lower, middle and upper reaches. Bozard Creek had a fredle index value of 1 .1, while West Lake Creek had a value of 0.4 and Upper Lake Creek had a Fredle index value of 0.1.

Average predicted cutthroat trout survival was 87.9% for lower reach, 96.7% for the middle reach and 67.4% for the upper reach of Benewah Creek (Table 3.38). Cutthroat survival rates for Alder Creek were calculated at 90.6% for the lower reach, 97.5% for the middle reach and 86.1% for the upper reach. Evans Creek had predicted survival rates of 59.3%, 78.6% and 83.1% for the lower, middle and upper reaches, respectively. Lake Creek had predicted survival rates of 74.2, 69.5, and 54.0% for the lower, middle and upper reaches respectively. Bozard Creek had a predicted survival rate of 19.3%, while West Lake Creek had a survival rate of 5.4% and Upper Lake Creek had a survival rate of 0.0%.

3.2. BIOLOGICAL EVALUATION

3.2.1. Relative Abundance

In May, July and September, 1992, a total of 23.3 electroshocking hours were spent collecting relative abundance information. A total of 1,881 fish were collected from the four tributaries (Table 3.39). In May and July, shocking effort was lower then in September, therefore the sample reflected the lower effort by the lowere number of fish captured. In Lake Creek, a total of 521 fish were captured with sculpin species being the most abundant species at 53.4%. In Benewah Creek, 367 total fish were captured with redside shiners comprising 40.1%. A total of 275 fish were captured in Alder Creek, with eastern brook trout being the most abundant at 44.4%. In Evans Creek, a total of 241 fish were captured and the most abundant was cutthroat trout at 98.8%. Cutthroat trout densities were highest in Evans Creek, followed by Alder (22.9%), Benewah (4.5%) and Lake Creeks (1.9%) (Table 3.40). Relative abundance data for each month, reach and stream can be found in Appendix E.

3.2.1.1. Lake Creek

In May, July and September a total of 3, 0 and 518 fish were collected in Lake Creek, respectively (Table 3.41). Of the three fish collected in May, two (66.6%) were cutthroat trout and one (33.3%) was a rainbow x cutthroat hybrid (Table 3.42). Both cutthroat trout

Table 3.39. Number of each species of fish caught by electrofishing at each Coeur d'Alene tributary during 1992.

Species Shock time (min)	Alder 504	Benewah 367	Evans 414	Lake 309
Cutthroat trout	63	38	238	10
Eastern brook trout	122	2	1	
Rainbow x cutthroat	1			1
Rainbow	1			
sculpin spp.	84	2		278
Longnose sucker	2	22		
Northern squawfish		2		
Largemouth bass		113	1	
Pumpkinseed			1	
Redside shiner		338		
Dace *spp.*	2	326		232
TOTAL	***275***	***843***	***241***	***521***

Table 3.40. Percent of each species of fish caught by electrofishing at each Coeur d'Alene tributary during 1992.

Species	Alder	Benewah	Evans	Lake
Cutthroat trout	22.9	4.5	98.8	1.9
Eastern brook trout	44.4	0.2	0.4	
Rainbow x cutthroat	0.4			0.2
Rainbow	0.4			
Sculpin *spp.*	30.5	0.2		53.4
Longnose sucker	0.7	2.6		
Northern squawfish		0.2		
Largemouth bass		13.4	0.4	
Pumpkinseed			0.4	
Redside shiner		40.1		
Dace *spp.*	0.7	38.7		44.5

Table 3.41. Number of each species of fish caught by electrofishing in Lake Creek during May - September, 1992.

Species Shock time (min)	May 96	July 95	September 118
Cutthroat trout	2		8
Rainbow x cutthroat	1		
Sculpin *spp.*			278
Dace *spp.*			232
TOTAL	***3***	***0***	***518***

Table 3.42. Percent of each species of fish caught by electrofishing in Lake Creek during May - September, 1992.

Species	May	July	September
Cutthroat trout	66.6		1.5
Rainbow x cutthroat	33.3		
Sculpin *spp.*			53.7
Dace *spp.*			44.8

Table 3.43. Electrofishing relative abundance for salmonid species by age class in Lake Creek, 1992.

	Cutthroat trout		
Age	5/92	7/92	9/92
0+			5 (62.5)
1+	2 (100.0)		3 (37.5)
2+			
3+			

were a year old (Table 3.43). No fish were captured in Lake Creek in July. For the month of September, 278 of the fish captured were sculpin species.(53.7%), 232 were dace species (44.8%), and 8 were cutthroat trout (1.5%). Of the eight cutthroat trout collected five were 0+ years of age and three were 1+ years of age.

3.2.1.2. Benewah Creek

In May, July and September a total of 45, 4 and 794 fish were collected from Benewah Creek (Table 3.44). Of the 45 collected in May, twenty-four (53.3%) were cutthroat trout, 2 (4.4%) were eastern brook trout, twelve (26.7%) were longnose sucker, two (4.4%) were northern squawfish and 5 (11 .1%) were redside shiner (Table 3.45). Of the 24 cutthroat captured, eight (33.3%) were 1 years of age, 14 (58.3%) were 2 years of age and two (8.3%) were 5 years of age (Table 3.46). All four fish collected in July in Benewah Creek were cutthroat trout with three (75.0%) being 2 years of age and one (25.0%) being 3 years of age. Of the 794 fish collected from Benewah Creek in September, 333 (41.9%) were redside shiner, 326 (41 .1%) were dace species, 113 (14.2%) were largemouth bass, ten (1.3%) were cutthroat trout, ten (1.3%) were longnose sucker and 2 (0.3%) were sculpin species. Of the ten cutthroattrout captured, one (10.0%) was 0 years of age and nine (90.0%) were 2 years of age.

3.2.1.3 Alder Creek

A total of 148, 11 and 117 fish were captured in Alder Creek in May, July and September, respectively (Table 3.47). Of the 148 fish collected in May, 84 (56.8%) were sculpin species, 44 (29.7%) were eastern brook trout, 13 (8.8%) were cutthroat trout, 2 (1.4%) were longnose sucker, 2 (1.4%) were dace species 1 (0.7%) was a rainbow x cutthroat hybrid and 1 (0.7%) was a rainbow (Table 3.48). Of the thirteen cutthroat trout captured in Alder Creek during May, ten (76.9%) were age l+,one (7.7%) was age 2+ and two (15.4%) were age 3+. Of the 44 eastern brook trout captured, twelve (27.3%) were 1+ years of age, 15 (34.1%) were 2+ years of age, 12 (27.3%) were 3+ years of age, 2 (4.5%) were 4+ years of age and 3 (6.8%) were age 5+ (Table 3.49). Of the eleven fish captured from Alder Creek in July, nine (81.8%) of the fish collected were eastern brook trout and two (22.2%) were cutthroat trout. Three (33.3%) of the nine brook trout collected were age 1+, 4 (44.4%) were age 2+, and the remaining 2 **(22.2%)** were age 3+. Of the two cutthroat trout captured, one

Table 3.44. Number of each species of fish caught by electrofishing in Benewah Creek during May - September, 1992.

Species Shock time (min)	May 98	July 107	September 162
Cutthroat trout	24	4	10
Eastern brook trout	2		
Largemouth bass			113
Sculpin spp.			2
Longnose sucker	12		10
Northern squawfish	2		
Redside shiner	5		333
Dace *spp.*			326
TOTAL	***45***	***4***	***794***

Table 3.45. Percent of each species of fish caught by electrofishing in Benewah Creek during May - September, 1992.

Species	May	July	September
Cutthroat trout	53.3	100	1.3
Eastern brook trout	4.4		
Largemouth bass			14.2
Sculpin *spp.*			0.3
Longnose sucker	26.7		1.3
Northern squawfish	4.4		
Redside shiner	11.1		41.9
Dace *spp.*			41.1

Table 3.46. Electrofishing relative abundance for salmonicl species by age class in Benewah Creek, 1992.

Age	Cutthroat trout 5/92	7/92	9/92
o+			1 (10.0)
1+	8 (33.3)		
2+	14 (58.3)	3 (75.0)	9 (90.0)
3+		1 (25.0)	
4+			
5+	2 (8.3)		

Table 3.47. Number of each species of fish caught by electrofishing in Alder Creek during May - September, 1992.

Species Shock time (min)	May 168	July 100	September 236
Cutthroat trout	13	2	48
Eastern brook trout	44	9	69
Rainbow x cutthroat	1		
Rainbow	1		
Sculpin spp.	84		
Longnose sucker	2		
Dace *spp.*	2		
TOTAL	***148***	***11***	***117***

Table 3.48. Percent of each species of fish caught by electrofishing in Alder Creek during May - September, 1992.

Species	May	July	September
Cutthroat trout	8.8	22.2	41 .o
Eastern brook trout	29.7	81 .8	58.9
Rainbow x Cutthroat	0.7		
Rainbow	0.7		
Sculpin *spp.*	56.8		
Longnose sucker	1.4		
Dace *spp.*	2.0		

Table 3.49. Breakdown of electrofishing relative abundance for salmonid species by age class in Alder Creek, 1992.

	Cutthroat trout			Eastern brook trout		
Age	5/92	7/92	9/92	5/92	7/92	9/92
0 +			28 (58.3)			
1 +	10 (76.9)	1 (50.0)	3 (6.3)	12 (27.3)	3 (33.3)	3 (4.3
2 +	1 (7.7)	1 (50.0)	12 (25.0)	15 (34.1)	4 (44.4)	24 (34.8)
3 +	2 (15.4)		5 (10.4)	12 (27.3)	2(22.2)	20 (29.0)
4 +				2 (4.5)		11 (15.9)
5 +				3 (6.8)		11 (15.9

(50.0%) was 1+ years of age and one (50.0%) was 2+ years of age. In September, one hundred seventeen fish were collected in Alder Creek. Of those 117 fish, 69 (58.9%) were eastern brook trout and 48 (41.0%) were cutthroat trout. Of the 69 eastern brook trout, 3 (4.3%) were 1+ years of age, 24 (34.8%) were 2+ years of age, 20 (29.0%) were 3+ years of age, 11 (15.9%) were 4+ years of age and 11 (15.9%) were 5+ years of age. Of those 48 cutthroat trout, 28 (58.3%) were 0+ years of age, 3 (6.3%) were 1+ years of age, 12 (25.0%) were 2+ years of age and five (10.4%) were 3+ years of age.

3.2.1.4. Evans Creek

A total of 23, 62 and 156 fish were captured in Evans Creek during May, July and September, respectively (Table 3.50). All 23 (100%) fish captured in May were cutthroat trout (Table 3.51). Of the 23 cutthroat captured, 12 (52.2%) were 1+ of age, 7 (30.4%) were 2+ of age, 1 (4.3%) was 3+ of age, and 3 (13.0%) were 4+ of age (Table 3.52). In July, all 62 fish collected were also cutthroat trout. Of the 62 cutthroat, 1 (1.6%) was 0+, 26 (41.9%) were 1+ years of age, 18 (29.0%) were 2+ years of age, 8 (12.9%) were 3+ years of age, and 9 (14.5%) were 4+ years of age. Of the 156 fish collected from Evans Creek in September, 153 (98.1%) were cutthroat trout, 1 (0.6%) was an eastern brook trout, 1 (0.6%) was a largemouth bass, and 1 (0.6%) was a pumpkinseed. Of the 153 cutthroat trout collected, 42 (27.5%) were 0+ years of age, 56 (36.6%) were 1+ years of age, 34 (22.2%) were 2+ years of age, 13 (8.5%) were 3+ years of age and eight (5.2%) were 4+ years of age 1.

3.2.2. Population estimates

In September, population estimates were conducted in four selected tributaries. Population estimates, 95% confidence intervals and fish densities for each trout species capture in Lake Creek can be found in Table 3.53. Cutthroat trout were the only trout population estimated for Lake Creek (Table 3.53). Reach one had an estimated cutthroat population of 4.0 ± 0.0 for 253 m^2 with a density of 1.6 ± 0.0 per 100 m? In reach two cutthroat populations were estimated at 0.0. In reach 3 cutthroat populations were estimated at 4.0 ± 0.0 for 142 m^2, with a density of 2.8 ± 0.0 for $100m^2$.

Population estimates, 95% confidence intervals and fish densities for each trout species captured in Benewah Creek can be found in Table 3.54. Only cutthroat trout populations could be

Table 3.50. Number of each species of fish caught by electrofishing in Evans Creek during May - September, 1992.

Species Shock time (min)	May 103	July 133	September 178
Cutthroat trout	23	62	153
Eastern brook trout			1
Largemouth bass			1
Pumpkinseed			
TOTAL	23	62	156

Table 3.51. Percent of each species of fish caught by electrofishing in Evans Creek during May - September, 1992.

Species	May	July	September
Cutthroat trout	100	100	98.1
Eastern brook trout			0.6
Largemouth bass			0.6
Pumpkinseed			0.6

Table 3.52. Breakdown of electrofishing relative abundance for salmonid species by age class in Evans Creek, 1992.

	Cutthroat trout		
Age	5/92	7/92	9/92
o+		1 (1.6)	42 (27.5)
1 +	12 (52.2)	26 (41.9)	56 (36.6)
2 +	7 (30.4)	18 (29.0)	34 (22.2)
3 +	1 (4.3)	8 (12.9)	13 (8.5)
4 +	3 (13.0)	9 (14.5)	8 (5.2)

Table 3.53. Estimated population, 95% confidence intervals, and fish density for each trout species captured in Lake Creek at each reach in September, 1992.

Species	Est. Pop.	95% C.I.	#/100m2 ± 95% C.I.
Reach #1 (253 m^2)			
CTT	4.0	±0.0	1.6 ± 0.0
Reach #2 (240 m^2)			
CTT	0.0	±0.0	0.0 ± 0.0
Reach #3 (142 m^2)			
CTT	4.0	±0.0	2.8 ± 0.0

Table 3.54. Estimated population, 95% confidence intervals, and fish density for each trout species captured in Benewah Creek at each reach in September, 1992.

Species	Est. Pop.	95% C.I.	#/100m2 ± 95% C.I.
Reach #1 (244 m^2)			
CTT	3.0	±0.0	1.2 ± 0.0
Reach #2 (230 m^2)			
CTT	5.0	±0.0	2.2 ± 0.0
Reach #3 (237 m^2)			
CTT	2.0	±0.0	0.8 ± 0.0

estimated for Benewah Creek due to low sample size of other trout species. In reach one, the estimated population of cutthroat trout was 3.0 ± 0.0 for 243.6 m^2 with a density of 1.2 ± 0.0 per 100 m? The estimated population of cutthroat trout for reach two was 5.0 ± 0.0 for 230 m^2, with a density of 2.2 ± 0.0 per 100 m? In reach three, the estimated cutthroat trout population in 2.0 ± 0.0 for 237 m^2 **with a density of 0.8 ± 0.0 per 100** m^2

Cutthroat and eastern brook trout populations were estimated for Alder Creek (Table 3.55). In reach one, cutthroat trout populations were estimated at 4.0 ± 0.0 fish for 274 m^2 , with a density of 1.5 ± 0.0 per 100m^2. Eastern brook trout populations were estimated at 3.0 ± 0.0 fish for 274 m^2, with a density of 1 .1 ± 0.0 per 100 m? In Reach two, cutthroat trout populations were estimated at 59.3 ± 10.2 for 177.1 m^2, with a density of 33.5 ± 5.8 for 100 m^2. Population estimates for eastern brook trout were 6.0± 0.0 for 177.1 m^2 with a density of 3.4 ± 0.0 per 100 m^2. In reach three estimated cutthroat trout populations were 1 .O ± 0.0 for 303 m^2 with a density of 0.3 ± 0.0 per 100 m^2. Eastern brook trout populations were estimated at 41.7 ± 12.9 for 303 m^2 with a density of 13.8 ± 4.3 for 100 m^2.

Cutthroat trout populations were estimated for Evans Creek (Table 3.56). In reach 1, cutthroat populations were estimated at 0. In reach 2, cutthroat trout populations were 99.6 ± 8.8 for 177 m^2 with a density of 56.2 ± 4.97 for 100 m? In reach 3, cutthroat trout populations were estimated at 76.2 ± 15.9 for 178 m^2 with a density of 42.9 ± 8.9 for 100 m^2.

3.2.3. Spawning surveys

Spawning surveys were conducted on Lake, Benewah, Alder and Evans, creeks during early May. The entire stream length was surveyed to locate and identify redds. Because spawning surveys were conducted during spring runoff the ability to see the bottom of the stream channel, especially in mainstem areas, was difficult. Only one confirmed redd was located on lower Lake Creek, other redd **sites were suspected but the ability to confirm that they were** actually redds was difficult. No redds or potential redds were identifyed on any other streams.

Table 3.55. Estimated population, 95% confidence intervals, and fish density for each trout species captured in Alder Creek at each reach in September, 1992.

Species	Est. Pop.	95% C.I.	#/100m2 ± 95% C.I.
Reach #1 (274 m^2)			
CTT	4.0	±0.0	1.5 ± 0.0
EBT	3.0	0.0	1.1 ± 0.0
Reach #2 (177 m^2)			
CTT	59.3	±10.2	33.5 ± 5.8
EBT	6.0	± 0.0	3.4 ± 0.0
Reach #3 (303 m^2)			
CTT	1.0	±0.0	0.3 ± 0.0
EBT	41.7	±12.9	13.8 ± 4.26

Table 3.56. Estimated population, 95% confidence intervals, and fish density for each trout species captured in Evans Creek at each reach in September, 1992.

Species	Est. Pop.	95% C.I.	#/100m2 ± 95% C.I.
Reach #1 (150 m^2)			
CTT	0.0	±0.0	0.0 ± 0.0
Reach #2 (177 m^2)			
CTT	99.6	±8.8	56.2± 5.0
EBT	1.0	± 0.0	0.6 ± 0.0
Reach #3 (178 m^2)			
CTT	76.2	±15.9	42.9 ± 9.0

3.2.4. Migration Trap Data Analysis

Migration traps were installed in three tributaries on March 19-24, 1992. On March 19th, one upstream and one downstream migration trap were installed in Lake Creek . On March 23rd traps were installed in Benewah Creek and on March 24th traps were installed in Evans Creek. Traps were operated daily until June 1st at which time they were removed. A total of 196 longnose suckers, 31 cutthroat trout, one rainbow trout, one longnose dace, and one largemouth bass were collected in all tributaries during the sampling period.

Table 3.57 shows the number and species of each fish captured in the upstream and downstream migration traps in Lake Creek for each Month. During March, six cutthroat trout spawners were collected in the upstream trap. Sizes ranged from 318 to 368 mm. Of the six cutthroat, two were males, one was female and the others were undetermined. Based on back-calculated lengths, ages ranged from four to six years. In April, 20 cutthroat trout were captured in the upstream migration trap. Sizes ranged from 236 to 396 mm. Four of these fish were identified as males, while seven were identified as females and the remaining undetermined. Ages ranged from two to six years. One fish was two years of age, two were 3 years of age, five were 4 years of age, nine were 5 years of age and three were 6 years of age. No fish were captured in either trap in May and June (Table 3.58).

Table 3.59 shows the number and species of fish captured in the migration traps in Benewah Creek. In March, one cutthroat was captured in the upstream trap and one longnose dace was captured in the downstream trap. The cutthroat trout captured was 99 mm and was a one year old fish. In April no cutthroat were captured in either trap, however six longnose suckers ranging from 305 to 432 mm were captured in the upstream trap (Table 3.60). In May approximately 190 longnose suckers were captured in between the upstream and downstream traps. A rain event caused the water levels in Benewah to raise, causing a portion of the weir to wash out. No holes were found in the downstream trap, therefore, passage above the traps was impossible. The area was electrofished and no cutthroat were found, however 190 longnose suckers were captured. No fish were captured in June.

Table 3.61 shows the number and species of fish captured in

Table 3.57. Number of each species of fish caught in migration traps in Lake Creek during 1992

Species Trap location	March upstrm.	March dnstrm	April upstrm	April dnstrm	May upstrm	May dnstrm
Cutthroat trout	6		20	1		
Rainbow trout			1			
Total	***6***		***21***	***1***		

Table 3.58. Size ranges, year class and sex of each species of fish caught in migration traps in Lake Creek during 1992.

Trap location	Date	Species	Age	Sex	Length (mm)	Weight (g)
Upstream	3/92	CTT	4+	M	318	250
		CTT	5+	F	330	420
		CTT	5+	U	334	200
		CTT	5+	U	337	300
		CTT	5+	U	339	298
		CTT	6+	M	368	430
Upstream	4/92	CTT	2+	M	236	250
		CTT	3+	U	280	175
		CTT	3+	U	282	180
		CTT	4+	U	304	400
		CTT	4+	U	310	150
		CTT	4+	M	315	450
		CTT	4+	F	316	200
		CTT	4+	F	316	205
		CTT	5+	M	320	255
		CTT	5+	M	320	250
		CTT	5+	U	330	150
		CTT	5+	U	333	200
		CTT	5+	F	334	300
		CTT	5+	U	334	289
		CTT	5+	U	335	250
		CTT	5+	F	336	310
		CTT	5+	F	336	300
		CTT	6+	F	349	300
		CTT	6+	F	350	401
		Cl-T	6+	U	362	400
		RBT	6+	U	396	235
Downstream	4/92	CTT	1+	U	118	12

Table 3.59. Number of each species of fish caught in migration traps in Benewah Creek during 1992

Species Trap location	March upstrm.	 dnstrm	April upstrm	 dnstrm	May upstrm	 dnstrm
Cutthroat trout	1					1
dace *spp.*		1				
Longnose sucker			6		190	
Total	***1***	***1***	***6***		***190***	***1***

Table 3.60. Size ranges, year class and sex of each species of fish caught in migration traps in Benewah Creek during 1992.

Trap	Date	Species	Age *	Sex	Length (mm)	Weight (g)
Upstream	3/92	CTT	1+	U	99	2
Downstream	3/92	LND		U	70	2
Upstream	4/92	LNS			305	
		LNS			305	
		LNS			406	
		LNS			330	
		LNS			432	1132
		LNS			432	1359
	5/92	Approximately 190 LNS were captured between the upstream and downstream trap.				

Table 3.61. Number of each species of fish caught in migration traps in Evans Creek during 1992

Species Trap location	March upstrm.	dnstrm	April upstrm	dnstrm	May upstrm	dnstrm
Cutthroat trout	1		1			
Largemouth bass				1		
Total	*1*		*1*	*1*	*0*	*0*

Table 3.62 Size ranges, year class and sex of each species of fish caught in migration traps in Evans Creek during 1992.

Trap	Date	Species	Age *	Sex	Length (mm)	Weight (g)
Upstream	3/92	CTT	4+	U	205	195
Upstream	4/92	CTT	1+	U	114	29
Downstream	4/92	LMB			120	

* ***Ages are*** based ***on back calculation data***

Evans Creek. In March, one cutthroat trout 205 mm long was collected in the upstream trap. Based on back-calculated lengths this was a 4 year old fish. In April, one cutthroat trout was collected in the upstream trap. Length of the fish was 114 mm. Based on back calculated lengths this was a one year old fish (Table 3.62). One largemouth bass was collected in the downstream trap in April. No fish were collected in either trap during May and June.

3.2.5. Age, Growth and Condition

Lake Creek

A total of 32 scales were collected from cutthroat trout in Lake Creek for age determination. Back-calculated lengths for cutthroat trout at the first annulus ranged from 91 to 122 mm with a grand mean of 1 IO mm (Table 3.63). At the end of the second years growth, lengths ranged from 127 to 205 mm with a grand mean 177 mm. At the end of three years of growth, lengths ranged from 243 to 270 mm with a grand mean of 257 mm. Lengths ranged from 284 to 315 mm at the end of four years of growth, with a grand mean of 299 mm. At age 5, lengths ranged from 313 to 340 mm with a grand mean of 319 mm. At age 6, back calculated lengths for cutthroat trout averaged 348 mm.

Mean lengths, weights and condition factors for each age class of cutthroat trout in Lake Creek are listed in Table 3.64. Mean condition factors ranged from 0.6 for 4+ cutthroat trout to 1 .1 for 1+ cutthroat trout, with an overall mean of 0.8.

Benewah Creek:

A total of 26 scales were collected from cutthroat trout in Benewah Creek for age determination and back calculated growth. Mean back calculated lengths for cutthroat trout at the first annulus ranged from 72 to 88 mm with a grand mean of 82 mm (Table 3.65). At the formation of the second annulus lengths ranged from 108 to 123 mm with a grand mean of 109 mm. At the end of the third years growth mean sizes ranged from 141 to 211 mm with a grand mean of 164. The length at the fourth annulus was 262 mm and the length of the fifth annulus was 298 mm.

Mean lengths, weights and condition factors for cutthroat trout are listed in Table 3.66. Mean condition factors ranged from

Table 3.63. Mean back-calculated lengths at the end of each years growth (annulus formation) for each age class of cutthroat trout in Lake Creek, 1992.

Cohort	N	MEAN ± S.D. BACK CALCULATED LENGTH AT ANNULUS 1	2	3	4	5	6
1991	3	101 ± 4					
1990	3	91 ± 7	127 ± 12				
1989	2	122 ± 11	205 ± 43	267 ± 73			
1988	9	118 ± 10	197 ± 25	269 ± 32	315 ± 31		
1987	12	108 ± 13	164 ± 27	243 ± 25	284 ± 28	313 ± 28	
1986	3	116 ± 5.3	201 ± 27	270 ± 30	312 ± 10	340 ± 11	348 ± 25
GRAND MEAN	32	110 ± 13	177 ± 34	257 ± 33	299 ± 31	319 ± 28	348 ± 25
MEAN ANNUAL GROWTH INCREMENT		110	67	80	42	20	29

Table 3.64. Mean lengths, weights and condition factors for each age class of cutthroat trout in Lake Creek, 1992.

Age	N	Mean weight (g) ±SD	Mean length (mm) ±SD	Mean K_{tl} ±SD
0+	5	3.0 ± 0.7	72.6 ± 4.0	0.8 ± 0.1
1+	3	19.7 ± 6.7	119.7 ± 7.5	1.1 ± 0.2
2+	3	26.7 ± 12.9	142.7 ± 21.5	0.9 ± 0.1
3+	2	153.5 ± 47.4	285.0 ± 69.30	0.9 ± 0.8
4+	9	230.6 ± 57.0	332.2 ± 26.3	0.6 ± 0.2
5+	12	256.7 ± 86.4	319.7 ± 27.9	0.8 ± 0.2
6+	3	395.7 ± 86.1	355.7 ± 25.5	0.9 ± 0.3
Total				0.8 ± 0.3

Table 3.65. Mean back-calculated lengths at the end of each years growth (annulus formation) for each age class of cutthroat trout in Benewah Creek, 1992.

		MEAN ± S.D. BACK CALCULATED LENGTH AT ANNULUS				
Cohort	N	1	2	3	4	5
1991	8	88 ±10				
1990	15	79 ± 5	108 ±7			
1989	2	76 ±2	110 ±6	141 ± 20		
1988	0					
1987	1	72	123	211	262	298
GRAND MEAN	26	82 ± 8	109 ± 8	164 ± 43	262	298
MEAN ANNUAL GROWTH INCREMENT		82	27	55	98	36

Table 3.66. Mean lengths, weights and condition factors for each age class of cutthroat trout in Benewah Creek, 1992.

Age	N	Mean weight (g) ±SD	Mean length (mm) ±SD	Mean K_{tl} ±SD
0+	1	3	72	0.8
1+	8	12.4 ± 5.5	111.6 ± 18.2	0.8 ± 0.2
2+	14	14.2 ± 5.6	122.3 ± 10.1	0.8 ± 0.2
3+	2	22.5 ± 9.2	167 ± 16.9	0.5 ± 0.4
4+	0			
5+	1	250	313	0.8
Total				0.8 ± 0.2

0.5 for 3+ fish to 0.8 for all other age classes of cutthroat trout. An overall mean condition factor of 0.8 was calculated.

Alder Creek

A total of 24 scales were collected from cutthroat trout in Alder Creek. Back-calculated lengths for cutthroat trout at the first annulus ranged from 73 to 91 mm with a grand mean of 79 mm. At the formation of the second annulus lengths ranged from 128 to 138 mm with a grand mean of 124 mm. The length at the third annulus was 183 mm (Table 3.67).

Mean lengths, weights and condition factors for each age class of cutthroat trout are listed in Table 3.68. Mean condition factors ranged from 0.7 for 0+ to 1 .1 for 3+ cutthroat trout, with an overall mean condition factor of 0.8.

A total of 79 scales were collected from brook trout in Alder Creek. Mean lengths for first years growth ranged from 53 to 81 mm. with a grand mean of 66 mm. (Table 3.69). After second annulus formation lengths ranged from 107 to 122 mm. with a grand mean of 118 mm. At age 3, brook trout lengths ranged from 147 to 163 mm. with a grand mean of 160 mm. The range of lengths after four years of growth was 173 to 189 mm. with an overall mean of 187 mm. The back calculated length of the only five year old brook trout collected was 213 mm.

Mean lengths, weights and condition factors for each age class of brook trout in Alder Creek are listed in Table 3.70. The lowest mean condition factor was 0.94 for 1+ and 5+ fish. The highest condition factor was 1.20 for 2+ fish. The overall mean condition factor was 1 .1 1.

Evans Creek

A total of 87 scales were collected from cutthroat trout in Evans Creek for age determination. Back-calculated lengths for cutthroat trout at the first annulus ranged from 73 to 77 mm with a grand mean of 74 mm. At the end of the second years growth, sizes ranged from 114 to 124 mm with a grand mean of 118 mm. Lengths at the third annulus ranged from 150 to 171 mm with a grand mean of 154 mm. At the end of the fourth year of growth a grand mean of 204 mm was obtained (Table 3.71).

Table 3.67. Mean back-calculated lengths at the end of each years growth (annulus formation) for each age class of cutthroat trout in Alder Creek, 1992.

		MEAN ± S.D. BACK CALCULATED LENGTH AT ANNULUS		
Cohort	N	1	2	3
1991	16	83 ± 13		
1990	4	84 ± 10	138 ± 3910	
1989	4	91 ± 19	128 ±23	183 ± 24
GRAND MEAN	24	79 ± 23	124 ± 40	183 ±24
MEAN ANNUAL GROWTH INCREMENT		79	45	59

Table 3.68. Mean lengths, weights and condition factors for each age class of cutthroat trout in Alder Creek, 1992.

Age	N	Mean weight (g) ±SD	Mean length (mm) ±SD	Mean K_{tl} ±SD
o+	20	2.7 ± 0.9	71.4 ± 6.1	0.7 ± 0.1
1+	14	15.7 ± 7.9	119.6 ± 21.9	0.9 ± 0.1
2+	5	60.6 ± 40.9	179.4 ± 46.6	0.9 ± 0.1
3+	3	150.0 ± 86.6	234.7 ± 9.0	1.1 ± 0.5
Total				0.8 ± 0.2

Table 3.69. Mean back calculated lengths at the end of each years growth (annulus formation) for each age class of brook trout in Alder Creek, 1992.

		MEAN ± S.D. BACK CALCULATED LENGTH AT ANNULUS				
Cohort	N	1	2	3	4	5
1991	8	78.7±15.5				
1990	38	80.6±91.1	122.5±17.3			
1989	26	64.6±16.5	115.3±19.5	163.3±26.3		
1988	6	63.5±18.1	109.3±16.4	150.9±17.0	189.1±16.9	
1987	1	53.9±0.0	107.0±0.0	146.9±0.0	173.5±0.0	213.4±0.0
GRAND MEAN	79	66.4±16.7	118.3±18.3	160.5±24.8	186.8±16.5	213.4±0.0
MEAN ANNUAL GROWTH INCREMENT		66	52	42	29	26

Table 3.70. Mean lengths, weights and condition factors for each age class of brook trout in Alder Creek, 1992.

Age	N	Mean weight (g) ± SD	Mean length (mm) ± SD	Mean K_{tl} ± SD
1+	8	21.7±10.4	128.6±22.1	0.94±0.12
2+	38	40.8±29.2	153.4±21.6	1.20±1.47
3+	26	79.6±37.2	195.3±26.9	1.02±0.22
4+	6	121.7±50.0	215.0±18.6	1.17±0.26
5+	1	130.0±0.0	240.0±0.0	0.94±0.0
Total	79			1.11±1.03

Table 3.71. Mean back-calculated lengths at the end of each years growth (annulus formation) for each age class of cutthroat trout in Evans Creek, 1992.

		MEAN ± S.D. BACK CALCULATED LENGTH AT ANNULUS			
Cohort	**N**	**1**	**2**	**3**	**4**
1991	47	74 ± 12			
1990	22	73 ± 10	114 ± 15		
1989	15	77 ± 10	124 ± 19	150 ± 44	
1988	3	75 ± 5	120 ± 4	171 ± 10	204 ± 12
GRAND MEAN	87	74 ± 11	118 ± 17	154 ± 40	204 ± 12
MEAN ANNUAL GROWTH INCREMENT		74	44	36	50

Table 3.72. Mean lengths, weights and condition factors for each age class of cutthroat trout in Evans Creek, 1992.

Age	N	Mean weight (g) ±SD	Mean length (mm) ±SD	Mean K_{tl} ±SD
0+	15	2.1 ± 1.3	58.7 ± 7.0	1.0 ± 0.3
1+	46	11.3 ± 5.7	105.0 ± 17.2	0.9 ± 0.2
2+	21	28.7 ± 13.3	145.2 ± 17.6	0.9 ± 0.1
3+	15	63.8 ± 32.8	190.1 ± 29.5	0.9 ± 0.2
4+	3	73.3 ± 2.9	239.0 ± 5.3	0.5 ± 0.1
Total				10.9 ± 0.2

Mean lengths, weights and condition factors for each age class of cutthroat trout in Evans Creek are listed in Table 3.72. Mean condition factors ranged from 0.5 for 4+ cutthroat trout to 1 .O for 0+ fish with an overall mean of 0.9.

4.0. DISCUSSION

A literature review determined optimal habitat conditions for cutthroat and bull trout (Graves *et al.* 1991). These optimal habitat conditions for cutthroat and bull trout were then compared to the habitat which existed in surveyed streams. Habitat parameters assessed for the entire stream were; base stream flow, temperature, and dissolved oxygen. Each stream was divided into reaches and for each reach the available habitat was determined. Available habitat was identified through habitat typing, which identified pools, riffles and secondary channels. In conjunction with habitat typing, large organic (woody) debris, riparian vegetation, and land use were assessed to determine instream and overhanging cover. Substrate and percentage of fine sediment were also used to determine instream cover, as well as, predicted cutthroat emergence success. Biological data collected included trout population estimates, trout densities, trout stock assessment, and benthic macroivertebrate densities. All data was combined to determine potential limiting factors affecting cutthroat and bull trout in the surveyed streams.

Conclusions and recommendations on ways to increase the cutthroat and bull trout fisheries were determined.

4.1. Cutthroat trout

Optimal conditions for cutthroat trout can be characterized by clear cold water, silt free rocky substrate in riffle-run areas, an approximate 1 :1 pool-riffle ratio with areas of slow, deep water, well vegetated stream banks, abundant instream cover, and relatively stable water flow, temperatures, and stream banks (Graves *et al* 1991; Raleigh and Duff 1981).

The most critical period for maintaining quality trout habitat exists during summer in which base flow and high water temperatures exist. Base flow greater then 50% of the average annual flow is considered excellent, while a base flow of 25-50% is fair, and a base flow of <25% is poor for maintaining quality trout habitat (Hickman and Raleigh 1982; Wesche 1980). Optimal temperature ranges for juvenile and adult cutthroat trout are between 11 - 15.5 °C and avoidance occurs when temperatures exceed 21 °C (Hickman and Raleigh 1982). For embyro survival, optimal temperature ranges are between 7 - 11.5 °C, while acceptable ranges are between 3 - 16 °C.

Dissolved oxygen concentrations are also important in maintaining quality trout habitat. High water temperatures lessen the amount of dissolved oxygen present in the stream. Optimal dissolved oxygen concentrations range between 4.5-7.3 mg/l in water with temperatures lower than 15 °C, and 6.0 - 9.0 mg/l in water with temperatures above 15 °C (Hickman and Raleigh 1982).

Cutthroat trout use pools throughout their life cycle for rearing, overwintering, and resting. Preferred pool habitat can be characterized as large, deep, low velocity areas with adequate cover. Pools used for rearing must include 3-16% cover in the form of depth, turbulence or instream structures (Boussu 1954, Lewis 1969) Lateral habitat or side channels may replace pool habitat for rearing cutthroat trout. In winter, adult and subadult cutthroat trout will aggregate in deep wide pools with low to negative velocities with adequate escape cover (Wilson et al 1987, Peters 1988).

Large organic debris is a major component in the development of cover and pools for westslope cutthroat trout habitat (Pratt 1984; Lider 1985; Gamblin 1988). It also plays an important role in stream stability, habitat complexity, bedload storage, rearing habitat protection and macroinvertebrete densities.

Substrate size and the amount of fine sediments are important to cutthroat trout habitat for spawning, food production, overwintering and rearing habitat. For successful spawning and reproduction, cutthroat trout require an adequate amount of gravels between 2.0 and 6.0 cm in diameter with less then 10% fine sediments.

Substrate is also important for over-wintering habitat of cutthroat trout. For optimal winter and escape cover of fry and juveniles, 10% of the substrate ranges between 10-40 centimeters in diameter (Hickman and Raleigh 1982). When temperatures drop below 8 °C small fish utilize the substrate for hiding and under extreme environmental conditions, such as high velocities and ice formation, fry and subadults burrow into the substrate (Everest, 1969, Bjorn et al 1982). It has been documented that fine sediments reduce carrying capacity of essential pool habitat, and eventually eliminate pools (Bjornn et all 1977; Rhodes and Jones 1991).

Cutthroat trout cover can be classified as instream and overhanging cover. Useable instream cover is associated with water at least 1.5 feet deep and less than 15 cm/sec velocity (Hickman and Raleigh 1982). For overhanging cover, it is estimated that 50-100% shade is acceptable habitat for cutthroat trout in streams less than 50 feet wide (Idyll 1942; Hunt 1975; Martin et al 1981). Canopy cover is also important in providing temperature control, contributing to the energy budget, allochthonous input to the stream, controlling watershed erosion and maintaining streambank integrity. A stream-side buffer of approximately 33 meters, of which 80% is either well-rooted and vegetated or has stable rocky streambanks, will maintain adequate erosion control (Raleigh and Duff 1981).

For a complete literature review of cutthroat trout reference Graves *et al.* (1991).

4.1.1. Lake Creek

Parameters determined for the entire Lake Creek drainage were base flow, temperature, and dissolved oxygen.

During 1991 and 1992 low flow conditions existed in Lake Creek. In 1991 base flow was 1.9 cfs (cubic feet per second) and in 1992 was 0.4 cfs (Table 4.1). The most critical period for quality trout habitat exists during base flow conditions. In 1991 and 1992 base flow was 13.4% and 25.2% of the average annual flow, respectively. This is far below the recommended 50% average annual flow for adequate trout habitat. For the last six years, including 1991 and 1992, this region has been experiencing a drought which has greatly impacted water yield in the streams, as well as, the quantity and quality of cutthroat trout habitat.

Maximum summer water temperatures in Lake Creek were 23” C and 17°C for 1991 and 1992, respectively (Table 4.1). Temperatures exceeded the optimal range for cutthroat (1 l-1 5.5°c) during 1991 and 1992, and avoidance temperatures (21°C) for cutthroat trout were exceeded during 1991. During the spawning season (April-June), when there were potential embryos existing in the stream, temperatures were in the acceptable range for cutthroat

Table 4.1. Stream characteristics of Lake Creek collected in 1991 and 1992.

		LAKE CREEK	
Stream reach	Lower	Middle	Upper
Fish densitv (m2)			
Cutthroat			
1991		.12	.04
1992	.02	0	.03
Eastern brook trout			
1991	0	0	0
1992	0	0	0
Bull trout			
1991	0	0	0
1992	0	0	0
Geometric means (%fines)			
1992	19.2 (6.0)	20.1 (5.2)	20.0 (24.6)
% survival			
1992	74	69	54
% canopy (mean)			
1992	18	0	0
Maximum water temperature (°C)			
1991	23	23	23
1992	25	25	25
Q (base flow in CFS)			
1991	1.9	1.9	1.9
1992	0.4	0.4	0.4
Dissolved oxvaen			
1991	6.5	8.5	11.8
1992	*	12.2	*
Residual pool mean depth (M)			
1992	0.4	0.6	0.5
%pools/%riffle			
1992	8/92	15/85	.1/99.9
Larae Organic Debris			
1992 logs	244	19	53
1992 root wads	18	1	1
Maior Land Use			
1992	97% forested	89% forested	78% agriculture

-data not collected

trout in 1991 and optimal in 1992.

Dissolved oxygen concentrations in Lake Creek for 1991 and 1992 (Table 4.1) were well within acceptable ranges.

Lower Lake Creek

In lower Lake Creek pools accounted for only 8% of the total habitat, while secondary channels or side channels were non existent. During base flow an average residual pool depth (the amount of water that would be present during zero flow) of 0.36 meters was calculated (Table 4.1). Taking into account the amount of pools and the residual depths, water/habitat that would remain during base flows is extremely minimal. Based on the lack of pool habitat it is questionable if this reach can sustain trout populations during periods of low flow and during winter.

Since pool habitat was lacking, cover became a critical component within this reach. The riparian zone was 97% forested, however, the trees were young and grasses dominated within 50 feet of the stream channel. Large organic debris (LOD) was present in the stream channel, however the young seral stage of the standing trees indicated a lack of present LOD recruitment. Mean canopy cover was 18% which indicated that the riparian area provided very little shading to the stream channel.

Instream cover for escape and winter cover, was provided by the large organic debris present in the system instead of substrate related cover. An average geometric mean (mean substrate size) of 19.2 mm was calculated. For optimal escape and winter cover substrate between IO-40 cm is optimal indicating that little instream cover existed from substrate. However, LOD located within the channel may provide escape and winter cover for cutthroat trout.

Substrate and percent fines were also important in determining the average percent survival from egg to swim up fry. Six percent fine substrate was calculated for this reach for a 74% egg to swim up fry survival rate, indicating silt was not a major problem.

Low habitat availability,namely pools, was directly correlated to cutthroat trout densities. In 1992 cutthroat trout densities were 1.6 fish/100m^2 for this reach. These densities are low compared to

Table 4.2 Comparison of cutthroat trout densities in Northern Idaho tributaries (#/100m^2).

Location	Density		Reference
Coeur d'Alene River Tributaries.			
Brown Creek, ID.	9.3		Apperson et *al.*, (1988)
Copper Creek, ID.	1.6		Apperson et *al.*, (1988)
Cougar Gulch, ID	18.3		Apperson et *al.*, (1988)
Evans Creek, ID (1984)			
Site 1	27.5		Apperson *et* al., (1988)
St. Joe Tributaries.			
Benewah Creek (1984)			
Site 1	1.4		Apperson et *al.*, (1988)
Site 2	3.2		
Site 3	1.7		
Bond Creek			
Site 1	1.6		Apperson et *al.,* (1988)
Site 2	4.0		
Trout Creek			
Site 1	14.5		Apperson et *al.,* (1988)
Site 2	58.6		
St. Maries River Tributaries			
Alder Creek (1984)			
Site 1	3.8		Apperson et al., (1988)
Site 2	14.2		
Merry Creek			
Site 1	7.6		Apperson *et al.*, (1988)
Site 2	26.0		
Tributaries in current study			
	'91	'92	
Benewah Creek, ID			
Lower	0.0	1.2	Lillengreen et *al.* (1992) &
Middle	0.7	2.2	Present study
Upper	3.6	0.8	
Aider Creek, ID			
Lower		1.5	Lillengreen et *al.* (1992) &
Middle	1.8	33.5	Present study
Upper	1 .l	0.3	
Lake Creek, ID			
Lower		1.6	Lillengreen et *al.* (1992) &
Middle	12.1	0.0	Present study
Upper	3.8	2.8	
Evans Creek, ID			
Middle	15.8	56.2	Lillengreen et *al.* (1992) &
Upper	24.1	42.9	Present study

other North Idaho cutthroat trout streams (Table 4.2).

Middle Lake Creek

In the middle reach of Lake Creek, pools comprised 15% of the available habitat. No side channels or lateral habitat was found. An average residual pool depth of 0.64 meters was calculated. Pool habitat was well below optimal for cutthroat trout (Table 4.1).

With pool habitat lacking, cover became a critical component for cutthroat trout survival in this reach. The riparian zone was 89% forested and 9% livestock grazing. Average canopy

cover was 0% indicating that very little shading of the stream channel occurred from the riparian zone. Most of the forested area consisted of young trees, grass and forb with low numbers of large organic debris located within the stream channel.

A geometric mean of 20.1 mm was calculated for substrate within this reach, which falls into the optimal size for cutthroat trout spawning gravels. Percent fine sediment in this reach was calculated at 5.2%, and calculated emergence success was 695% indicating that silt loading was not a major problem.

Low habitat availability was correlated to trout densities. In 1991, the middle reach had densities of 12.1 cutthroat/100m^2 and in 1992 had densities of 0.0 cutthroat /100m^2 for the middle reach These densities are low compared to other North Idaho streams (Table 4.2).

Upper Lake Creek

In the upper reach of Lake Creek pools comprised 0.1% of the habitat. A residual pool depth of .52 meters was calculated. Habitat in this reach consisted mainly of glides formed from old beaver dams.

Since pool habitat was lacking in the upper reach of Lake Creek, cover was again a critical component for cutthroat trout habitat. In the upper reach of Lake Creek the riparian area was 78% agriculture (barren fields) and 7% forested. Mean canopy cover was 0%. Large woody debris growing adjacent to the stream channel for shading and future recruitment of large organic debris to the stream channel was nonexistent.

Limited cover existed from LOD present in the system and no cover existed from substrate.

Twenty-four percent fines were calculated for this reach. Calculated emergence success values was 54.0% survival from egg to swim up fry. This reach was the only reach in which spawning gravels were abundant (gravels between 2-6 cm). However, this was also the site in which high percent fines were calculated.

Low habitat availability and high percentages of fine sediment correlated to low densities of cutthroat trout. Densities of 3.9 cutthroat/100m^2 and 2.8 cutthroat/100m^2 for 1991 and 1992 were calculated. These densities are low compared to other North Idaho streams (Table 4.2).

Conclusion and Recommendations for Lake Creek

Overall, the lack of pools in Lake Creek may be an indication of cumulative silt loading. Habitat surveys showed that 90% of the pools identified in Lake Creek were over 1.5 feet deep but only accounted for 9.4% of the total habitat surveyed. All three reaches lacked pool habitat therefore it is questionable if trout populations could be supported during periods of low flow and during winter.

Lake Creek has a limited riparian area for stream temperature control, erosion control or future recruitment of large organic debris.

Macroinvertebrate density data collected in 1991 (Lillengreen *et al* 1992) indicated that productivity in Lake Creek was comparable to other streams **which support healthy cutthroat trout populations. Therefore, food production was not a major limiting factor.**

Habitat conditions in Lake Creek which could have contributed to the low numbers of cutthroat trout and recommendations on ways to **improve cutthroat trout habitat are:**

Habitat condition	
*	Optimal maximum water temperatures for embyro, juvenile and adult life history stages were exceeded both years, and in 1992 the accepted temperature range was exceeded.

Recommendation:

* Increase the amount of stream shading through riparian vegetation management. These management techniques could include the following; fences, buffer strips, planting.

Habitat condition

* Base flow of 13.4% and 25% of average annual flow for 1991 and 1992.

Recommendation

* Partially caused by low snow pack, but also water retention time decreased due to the lack of riparian and upland vegetation. Increase riparian and upland vegetation as stated above.

Habitat condition

* Cumulative effects of silt loading has decreased the amount of pool habitat present, which in turn affects overwintering as well as rearing habitat.

Recommendation

Decrease sediment from a watershed approach "treat headwater areas" Instate BMP's (Best management

practices) for timber, agriculture and grazing land uses. BMP's could include but are not limited to riparian leave zones for both timber and agriculture and rest-rotation schedules for livestock grazing. Instream structures may be built to create more pool habitat Also substrate cleaning is a viable option but should only be considered after instream and upland sediment recruitment has beer abated. Restoring stable channel geomorphology is also recommended.

Habitat condition

* Rioarian area is lackinq for LOD recruitment.

Recommendation

Plant hardwoods for future recruitment of large organic debris as well as shrubs

Habitat condition

Channel Instability

Recommendation

All these conditions have, in part, been factors creating a disequilibrium in the stability of the channel. To a large extent land uses have predisposed the system to this instability. By following the above recommendations channel stability will, over time, improve. Also channel stabilization measures will be conducted for short term protection.

4.1.2. Benewah Creek

Parameters determined for the entire Benewah Creek drainage were base flow, temperature and dissolved oxygen.

Low flow conditions existed in Benewah Creek during 1991 and 1992. In 1991 base flow was 1.9 cfs and in 1992 was 0.6 cfs. Base flow in 1991 was 13.2% and in 1992 was 4.9% of the average annual flow (Table 4.3). Both base flows are below the average annual flow that is needed to maintain quality trout habitat. Low snow-pack and low water retention time from land-use practices were major contributors to the low base flow.

Maximum stream temperature in Benewah Creek were 24°C and 17°C for 1991 and 1992, respectively (Table 4.3). The maximum stream temperature for cutthroat trout (21 °C) was exceeded in 1991 indicating that cutthroat trout may have shown avoidance. Temperatures were collected once monthly, therefore, if these high temperatures existed for 7 days or more is unknown. High temperatures existing in a stream for seven days or more cause cutthroat trout to abandon these areas (Hickman and Raliegh 1982))

Dissolved oxygen concentrations were optimal for cutthroat trout (Table 4.3).

Lower Benewah Creek

In the lower reach of Benewah Creek 6% of the available habitat was pools. No side channels or lateral habitat existed. A mean residual pool depth of .4 meters was calculated (Table 4.3). Sufficient pool habitat associated with instream cover was not available in this reach, therefore it is questionable if cutthroat would utilize this area.

Cover within this reach was limited to a few pieces of large organic debris present in the stream channel. The riparian zone was dominated by shrubs and grasses which in turn resulted in an average canopy cover of 4.9%.

Various substrate sizes found in the lower reach of Benewah Creek may be used as over-wintering cover for cutthroat trout. Another area of concern in Benewah Creek was the possibility of severe bedload movement. The amount of cleared uplands, lack of canopy and riparian vegetation and compaction from grazing has increased bedload movement (Rhodes and Jones 1991). Bedload movement occurs during rain, rain on snow, or spring runoff. During spring spawning season, bedload movement scours the streambed, destroying redds. During winter events bedload movement may kill fish using the substrate as overwintering habitat.

A percent fine value of 3.1 was calculated for this reach with a geometric mean of 30 mm. An 87.9% survival from egg to swim up fry existed (Table 4.3). Optimal gravel sizes with low silt percentages existed in this reach which indicated that spawning gravels and silt were not a limiting factor for cutthroat trout.

Trout densities were once again correlated to available habitat as well as high water temperatures. Trout densities for the lower reach of Benewah Creek were 0 trout/100m^2 and 1.2 trout/l 00m^2 for 1991 and 1992, respectively (Table 4.3).

Middle Benewah Creek

In the middle reach of Benewah Creek 41% of the area was pool habitat. A residual pool depth of .41 meters was calculated and few pools had deep spots essential for rearing and escape cover. Most of the pools were formed by beavers and bedform scouring. Scouring

Table 4.3. Stream characteristics of Benewah Creek collected in 1991 and 1992.

	BENEWAH CREEK		
Stream reach	Lower	Middle	Upper
Fish densitv (m^2)			
Cutthroat			
1991	0	.01	.04
1992	.01	.02	.01
Eastern brook trout			
1991	0	0	0
1992	0	0	0
Bull trout			
1991	0	0	0
1992	0	0	0
Geometric mean(%fines)			
1992	29 (3.1)	27.4 (4.4)	13.3 (10.3)
% survival			
1992	88	97	67
% canopv (mean)			
1992	5	5	0
Maximum water temperature (°C)			
1991	24	24	24
1992	17	17	17
Q (base flow in CFS)			
1991	1.9	1.9	1.9
1992	0.6	0.6	0.6
Dissolved oxygen			
1991	14.2	16.4	14.9
1992	*	11.9	*
Residual pool mean depth (M)			
1992	0.4	0.4	1.o
° pools/%riffle			
1992	6/94	41/59	26/74
Larae Oraanic Debris (#)			
1992 logs	43	457	157
1992 root wads	4	17	12
Maior Land Use			
1992	39% residential	62% livestock	77% livestock

-data not collected

occurred due to unstable stream banks. Cattle grazed 62% of the riparian area, leaving unstable stream banks, little riparian vegetation and a mean canopy closure of 4.9%. Future recruitment of LOD did not exist, because of the high livestock grazing pressure (Table 4.3).

A percent fine value of 4.4 was calculated for the middle reach with a geometric mean of 27.4 mm (Table 4.3). Average cutthroat emergence success was estimated at 96.7%, which indicated that percent fines was not a limiting factor and that ample spawning size gravels existed in this reach.

The lack of adequate pool habitat with associated cover was thought to be the reason for the low numbers of cutthroat trout in this reach. Cutthroat trout densities of only 0.7 fish/l00 m^2 and 2.2 fish/l 00 m^2 were calculated for 1991 and 1992, respectively (Table 4.3).

Upper Benewah Creek

In the upper reach of Benewah Creek pools accounted for 26% of the available habitat. Three side channels for a total of 85.6 m^2 were also identified providing rearing habitat for young of the year and juvenile cutthroat trout. A mean residual pool depth of .97 meters was calculated for the reach in which dammed pools had a residual pool depth of 1.28 meters. In this reach there were 157 logs and 12 root wads and a mean canopy cover of 0.0%. Seventy-seven percent of the riparian area was grazed by livestock which contributed to the lack of LOD presently located in the stream channel. Future recruitment of LOD into this reach is limited due to the lack of large timber adjacent to the stream channel (Table 4.3).

Percent fines for upper reach was 10.3 with a geometric mean of 13.3 mm, respectively (Table 4.3). Average cutthroat emergence success was estimated at 67.4% which indicated that as percent fines increased survival from egg to swim up fry decreased (Irving and Bjornn 1977). Also, gravel sizes for cutthroat trout spawning were on the small side for this reach.

Highest cutthroat trout densities for Benewah Creek were found in the upper reach. Cutthroat trout densities of 3.6

trout/100m^2 and 0.8 trout1100 m^2 were calculated during 1991 and 1992, respectively. However, these densities are low in comparison to other North Idaho Streams (Table 4.2).

Conclusions and Recommendations for Benewah Creek

Overall, high water temperatures, low base flow and lack of available habitat in the form of deep pools associated with cover are major factors limiting cutthroat trout densities in Benewah Creek.

Macroinvertebrate densities collected in 1991 (Lillengreen et *al* 1992) indicated that macroinvertebrate densities were comparable to other low productivity high quality cutthroat trout streams in the area. Food production in Benewah Creek was not a limiting factor for cutthroat trout.

Habitat conditions in Benewah Creek which could contribute to the low numbers of cutthroat trout and recommendations on ways to improve cutthroat trout habitat are:

lYabitat Condition

* High water temperatures exceeded optimal cutthroat trout range during 1991 and 1992.

Recommendation

* Increase amount of stream shading through riparian vegetation management. These management techniques can include the following; fences, buffer strips, planting

lHabitat Condition

* Base flow below 50% annual stream flow for optimal trout habitat.

lRecommendation

* Partially caused by low snow pack, but also water retention time decreased due to the lack of riparian and upland vegetation. Increase riparian and upland vegetation as stated above.

Habitat Condition

* Excessive bedload movement.

Recommendation

* Reduce bedload movement through channel stabilization. Methods used could include restoring riparian vegetation establishing plants with large root masses and reconstruction of bank areas to level off and stabilize high cut bank areas.

Habitat Condition

* Lack of quality rearing and overwintering habitat

Recommendation

* Create deep pools. Beaver activity may assist in this task.

4.1.3. **Alder Creek**

Parameters determined for the entire Alder Creek drainage were base flow, temperature and dissolved oxygen.

Low flow conditions existed in Alder Creek during 1991 and 1992. In 1991 base flow was 18.8% of the average annual flow at 1.9 cfs and in 1992 was 8.5% of the average annual flow at 0.6 cfs (Table 4.4). Both are well below the average annual flow that is considered to maintain quality trout habitat. Low snow-pack and increased water yield from land-use practices are major contributing factors to the low base flow.

Temperature ranges in Alder Creek were within the acceptable range for cutthroat trout survival with maximum water temperatures of 19°C and 17°C for 1991 and 1992, respectively. Drought conditions and fairly open canopy are the main reasons for higher water temperatures outside of the optimal range of 11°C - 15.5°C (Table 4.4).

Dissolved oxygen concentrations were optimal for cutthroat trout.

Table 4.4. Stream characteristics of Alder Creek collected in 1991 and 1992.

Stream reach	Lower	ALDER CREEK Middle	Upper
Fish density (m2)			
Cutthroat			
1991		.02	.01
1992	.02	.34	0
Eastern brook trout			
1991		.04	.20
1992	.01	.03	.14
Bull trout			
1991	0	0	0
1992	0	0	0
Geometric mean (%fines)			
1992	24.7 (3.3)	33.8 (10.8)	21.7 (27.0)
% survival			
1992	91	97	86
% canopy (mean)			
1992	30	27	46
Maximum water temperature (°C)			
1991	19	19	19
1992	17	17	17
Q (base flow in CFS)			
1991	1.5	1.5	1.5
1992	0.6	0.6	0.6
Dissolved oxygen			
1991	11.4	10.8	14.6
1992	•	11.6	*
Residual pool mean depth (M)			
1992	0.4	0.4	0.5
%pools/%riffle			
1992	17/83	4/96	58/42
Larae Organic Debris (#)			
1992 logs	148	2	147
1992 root wads	17	1	30
Major I and Use			
1992	99% timber	79% timber	66% timber

-data not collected

Lower Alder Creek

In Lower Alder Creek pools accounted for 17% of the total available habitat. During base flow a residual pool depth of 0.41 meters was calculated indicating that during summer flows few if any of the pools had water 1.5 feet deep or deeper which is essential for winter and escape cover. Three side channels for a total of 366 meters were identified within this reach. Mean canopy cover in this section averaged 30% with a range of 0-99%. This percentage canopy is a critical component for stream temperature regulation and provides optimum conditions for invertebrate production. This reach also had 149 logs and 17 root wads indicating that LOD is relatively abundant for instream cover which is essential when low water depth exists. Ninety nine percent of the riparian zone was forested securing future recruitment of large organic debris.

In the lower reach of Alder Creek an average of 3.3% fines was calculated with a geometric mean of 24.7 mm. Cutthroat survival from egg to swim up fry was estimated at 90.6%, which indicated that silt was not a major limiting factor.

No trout densities were calculated for the lower section of Alder Creek during 1991. In 1992, densities were 1.5 cutthroat/l $00m^2$ and 1 .1 eastern brook trout/l $00m^2$. Cutthroat trout densities were low compared to other cutthroat trout streams in North Idaho (Table 4.2) while eastern brook trout densities were comparable to other North Idaho streams (Table 4.5).

Middle Alder Creek

In the middle reach of Alder Creek pool habitat accounted for only 4% of the available habitat. No lateral habitat (side channels) was identified within this reach. A residual pool depth of 0.37 meters was calculated with a mean canopy of 26.8% (Table 4.4). Large organic debris was limited to two logs and one root wad. A combination of these factors indicated that this reach would not be utilized by cutthroat trout. Cutthroat trout densities were 1.9 cutthroat trout/$100m^2$ and 3.6 eastern brook trout/$100m^2$ in 1991. In 1992, densities of 33.5 cutthroat trout/$100m^2$ and 3.4 eastern brook trout/$100m^2$ were calculated. A serious change in the available habitat was recorded during September when population estimates were conducted. This change was attributed to the

Table 4.5 Comparison of eastern brook trout densities in Northern Idaho tributaries ($\#/100m^2$).

Location	Density	Reference
Alder Creek (1984)		
Site 1	0.0	Apperson et **al.,** (1988)
Site 2	3.6	
Alder Creek (1991)		
Middle	3.5	Lillengreen et al., (1992)
Upper	19.9	
Alder Creek (1992)		
Lower	1.1	Present study
Middle	3.4	
Upper	13.8	
Benewah Creek (1984)	1.4	Apperson *et al.*, (1988)
Copper Creek		
Site 1	2.6	Apperson *et* al., (1988)
Site 2	4.6	
Fortier Creek	4.2	Apperson et al., (1988)
Homor Creek	31.3	Corsi & Elle (1989)
Leiberg Creek	0.1	Gamblin (1987)
Reeds Gulch	132.5	Apperson et *al.*, (1988)

migration of beaver into the area. Beaver dams had created pool habitat and a corresponding increase in trout numbers was observed (see Appendix F). Habitat

typing in this reach should be repeated to assess the beaver activity before any recommendation be made.

The middle reach had a calculated percent fine sediment of 10.8% and a substrate geometric mean of 33.8 mm. Survival from egg to swim up fry was estimated at 97.5% indicating that silt was not a problem and that ample amount of spawning gravels existed (Table 4.4).

Upper Alder Creek

In the upper reach of Alder Creek pool habitat accounted for 58% of the available habitat. Two side channels, for a total of 287 meters, were identified which provided lateral habitat for young of the year fish and juvenile rearing habitat. A residual pool depth of 0.46 m was calculated. Mean canopy cover was 46.3% with 147 logs and 30 root wads within this section. Future recruitment of LOD was limited in some areas because of past forest practices, such as removing timber from the riparian zone. However, most of the reach had high recruitment of LOD (Table 4.4).

The upper reach had 27.0% fines with a geometric mean of 21.7 mm. An egg to swim up fry survival rate of 86.1% was calculated. This indicated that spawning gravels were adequate, however, silt may limit the amount of fry survival.

Trout densities of 1.2 cutthroat /100m^2 and 19.9 eastern brook trout /100m^2 were calculated for 1991. Densities of 0.3 cutthroat trout/l 00m^2 and 13.8 eastern brook trout/l 00m^2 were calculated for 1992 (Table 4.4). One factor that may be limiting the densities of cutthroat trout in this reach is interspecific competition with eastern brook trout. It has been documented that eastern brook trout will actively displace cutthroat trout (Griffith, 1972).

Conclusions and Recommendations for Alder Creek

All stream reaches for both years, with the exception of the middle reach in 1992, had lower cutthroat trout densities when compared to other North Idaho Streams (Table 4.2). Brook trout densities were comparable (Table 4.5).

Macroinvertebrate densities collected in 1991 (Lillengreen et ***al*** 1992) showed similar production to other North Idaho streams supporting healthy westslope cutthroat trout populations. Food production was not a limiting factor.

Habitat conditions in Alder Creek which could contribute to the low numbers of cutthroat trout and recommendations on ways to improve cutthroat trout habitat are:

Habitat Condition

- Low base flows of 18.8% and 8.5% of annual flow for 1991 and 1992, respectively.

Recommendation

- Increase water retention time by increasing riparian vegetation. Monitor beaver activity documenting habitat changes.

Habitat Condition

- The presence of eastern brook trout in the system.

Recommendation

- Designate the upper reach of Alder Creek above the falls, impassable to adfluvial cutthroat trout and an area limited in resident cutthroat. Manage the upper reach of Alder Creek for resident cutthroat trout and discourage private eastern brook trout plantings.

Habitat Condition

- Lack of deep pool habitat for rearing and overwintering cutthroat trout.

Recommendation

- Create deep pools by using log wiers. Management of beaver activity may assist in this task by creating large dammed pools.

4.1.4. Evans Creek

Low flow conditions existed in Evans Creek during 1991 and 1992. In 1991, base flow was 1.9 cfs, 15.4% of the average annual flow, and in 1992 was 1.6 cfs, 15.4% of the average annual flow. Both years were below the average annual flow required to maintain quality trout habitat, but of all four streams surveyed, Evans has the best water retention (Table 4.6). Base flow would improve in Evans with an adequate snow-pack and termination of the local drought.

Maximum stream temperatures in Evans Creek were 15°C and 17°C for 1991 and 1992, respectively. The maximum stream temperature for cutthroat trout (21°C) was never exceeded. In 1992, during low water flow, the temperature did not rise above the optimal temperature range for cutthroat trout.

Dissolved oxygen concentrations were optimal for cutthroat trout (Table 4.6).

Lower Evans Creek

In the lower reach of Evans Creek pools comprised 15% of the available habitat. Mean canopy in this reach was 32.9% with 16 logs and 8 root wads as large organic debris. One hundred percent of the riparian area had been grazed by cattle which explained the 1800 meters of bank cutting in this reach (Table 4.6). The presence of cattle year round has destroyed the integrity of the stream bank and increased instream sedimentation.

A percent fine value of 40.7%, and a geometric mean of 12.1 mm was calculated for the lower reach (Table 4.6). Percent emergence success was calculated at 59.3% which indicated that as percent fines increased, and the average survival from egg to swim up fry decreased.

Cutthroat trout densities for the lower reach of Evans Creek were not estimated for 1991 and were $0.0/100m^2$ during 1992 (Table 4.6). This area served only as a migratory corridor for cutthroat trout and was completely avoided by the resident

Table 4.6. Stream characteristics of Evans Creek collected in 1991 and 1992.

	EVANS CREEK		
Stream reach	Lower	Middle	Upper
Fish density (m^2)			
Cutthroat			
1991		.16	.24
1992		.56	.43
Eastern brook trout			
1991	0	0	0
1992	0	0	0
Bull trout			
1991	0	0	0
1992	0	0	0
Geometric means (%fines)			
1992	12.1 (40.7)	19.5 (11.0)	21.7 (9.7)
% survival			
1992	59	79	83
% canopy (mean)			
1992	33	61	66
Maximum water temperature (°C)			
1991	15	15	15
1992	17	17	17
Q (base flow in CFS)			
1991	1.9	1.9	1.9
1992	1.6	1.6	1.6
Dissolved oxygen			
1991	13.9	8.9	14.9
1992	•	10.8	•
Residual pool mean depth (M)			
1992	0.5	0.4	
%pools/%riffle			
1992	15/85	20/80	38/62
Large Organic Debris (#)			
1992 logs	16	58	48
1992 root wads	8	3	0
Major Land Use			
1992	100% livestock	100% timber	97% timber

-data not collected

cutthroat trout population.

Middle Evans Creek

In the middle reach of Evans Creek, pools comprised 20% of the available habitat. This area had average residual pool depths of .37 meters (Table 3.6). This depth is not optimal habitat, but association with heavy overhanging cover and large organic debris provided sufficient habitat. Average canopy cover in this reach was 61% and a total of 58 logs and 3 root wads were counted. The numerous log jams were not included in the total woody debris count. Future recruitment of large organic debris is unlimited because of the large amount of standing trees adjacent to the stream channel. Areas of concern in this reach include future timber sales and the number of instream road crossings present.

A percent fine value of 11 .O% and a geometric mean of 19.5 mm . was calculated (Table 4.6). Survival from egg to swim up fry was calculated at 78.6%. This suggested that cumulative effects of silt loading in this reach could eventually limit trout densities. Ample spawning gravels were present, however, silt may be a factor in cutthroat trout survival. Whether trout use this area for spawning is unknown.

The middle reach of Evans Creek had cutthroat trout densities of 15.8 trout/100m^2 during 1991 and 56.2/1 00m^2 for 1992. These densities are similar to other cutthroat trout streams in North Idaho (Table 4.2).

Upper Evans Creek

In the upper reach of Evans Creek, 38% of the available habitat was in the form of pools. A residual pool depth of .31 meters was calculated for this reach. These lower pool depths were associated with large amounts of overhanging canopy (mean canopy cover of 66%) and numerous debris jams and logs (Table 4.6). Road crossings and future timber sales in the upper reach were a problem. Limited cattle grazing does exist in the upper reach of Evans Creek and is beginning to show degradation of the riparian area. Proper BMP's for grazing will reduce the cumulative effects.

A percent fine value of 9.7% and a geometric mean of 21.7 mm were calculated for this reach. Percent survival from egg to swim up fry was calculated at 83.1%. Spawning gravels were abundant in this reach and silt was not a major factor.

In the upper reach of Evans Creek cutthroat trout densities were 24 fish/l 00m^2 for 1991 and 42.9 fish/100m^2 for 1992. These densities are similar to other cutthroat trout streams in North Idaho (Table 4.2).

Conclusions and Recommendations for Evans Creek

Overall, Evans Creek is relatively undamaged. However, there are problem areas, mainly the lower reach. Proper best management practices will partially mitigate for present damages. Future land use activities in the drainage basin have serious connotations to the stability of Evans Creek and should be monitored to insure that BMP's are implemented.

Macroinvertebrate production for Evans Creek as reported in Lillengreen *et a/.* (1992) showed that food production was similar to other North Idaho streams producing viable cutthroat populations.

Habitat conditions in Evans Creek which could contribute to the decline of cutthroat trout and recommendations on ways to maintain cutthroat trout habitat are:

Habitat condition

* Stream protection zone and the water retention capability is optimal in most areas of Evans Creek.

Recommendation

* Monitor timber sales in the area to prevent disastrous effects on the drainage including enhancement of road or possible construction of new roads away from stream.

Habitat condition

* Lower reach has severe bank stability problems.

Recommendation

* Proper grazing strategies as well as re-establishment of riparian vegetation/ and root mass for bank stability.

4.2. Cutthroat trout stock assessment for surveyed streams.

In 1992, migration traps were installed to determine if adfluvial, fluvial or resident cutthroat were using the tributary. Stock determination was achieved through age and growth analysis as well as migratory tendencies.

4.2.1. Lake Creek

Data collected from Lake Creek showed that a remnant population of adfluvial and a resident population of cutthroat trout existed. This conclusion was based on age and growth analysis, migration trap data, and the outlet of Lake Creek is Lake Coeur d'Alene..

When comparing back calculated lengths to other tributaries known to contain adfluvial stocks of cutthroat trout, (Table 4.7) growth rates and ages obtained from cutthroat trout captured in the migration traps were comparable. In comparison, those tributaries in which resident stocks were found showed similar sizes to those cutthroat found during 1991 in the upper sections of Lake Creek. This indicated that a small population of resident cutthroat utilize the upper areas of Lake Creek.

The viability of the adfluvial stock is questioned since only 29 fish were captured in the traps. Sampling error may account for these low numbers of cutthroat since the migration traps were rendered inoperable at times during the spawning run. Of the 29 fish captured, eight were females with an average length of 333 mm. Based on average length and fecudity reported in literature, each female should produce approximately 6,127 eggs. Irving and Bjornn (1984) showed that survival from egg to swim-up fry may range from 0.4% to 95% in the laboratory depending upon the levels of fine sediment.
Based on the fact that spawning gravels were identified in the upper reach of Lake Creek, the percent fine value and percent emergence success calculated for the upper reach, was used to calculate the number of eggs that would survive to swim up fry. This value would calculate to approximately 3,308 cutthroat trout fry per female.

Table 4.7. Comparison of mean back-calculated lengths at annulus formation for cutthroat trout.

	Length at annulus formation					
	1	2	3	4	5	6
Tributaries to Priest Lake (Carlander, 1969)	86	127	170	201	254	
N. Idaho Tributaries (Carlander, 1969)						
Upper	53	102	152	224		
Lower	71	135	226	292		
Adfluvial		140	216			
East River, Priest River drainage, N. Idaho (Horner 1987)	95	136	171			
Big Creek, Priest River drainage, N. Idaho (Horner 1987)	81	121	154	177		
Cee Cee Ah Creek, WA (Barber et *al.* 1989)	94	134				
Tacoma Creek, WA (Barber et *al.* 1989)	101	140	182			
LeClerc Creek, WA (Barber et *al.* 1989)	93	137	178			
Benewah Creek, N. Idaho						
(Lillengreen et *al.* 1992) N=63	68	118	176	252	289	
(Present study) N=26	82	109	164	262	298	
Alder Creek, N. Idaho						
(Lillengreen et *al.* 1992) N=26	67	103	142			
(Present study) N=24	79	124	183			
Lake Creek, N. Idaho						
(Lillengreen et *a/.* 1992) N=79	60	107	135			
(Present study) N=32	110	177	157	199	319	348
Evans Creek, N. Idaho						
(Lillengreen et a/. 1992) N=124	67	101	138	185		
(Present study) N=87	74	118	154	204		
Fighting Creek, N. Idaho (Lillengreen *et* a/. 1992)	53	97	140			
Plummer Creek, N. Idaho (Lillengreen et a/. 1992)	70	124	175	211	253	

This figure multiplied by eight females equals 26,464 cutthroat trout fry for Lake Creek. The estimated seeding levels and the actual densities collected for the three reaches of Lake Creek do not correlate. One explanation can be that spawning is taking place in the headwater areas of the stream, which have higher embeddeness rates and therefore lower survival rates (See Appendix D). A second explanation could be due to habitat sampling methods in Lake Creek. Due to the failure of the traps, survey intensity levels and lack of definite data, further investigation is needed to determine accurate seeding levels for Lake Creek.

4.2.2. Benewah Creek

Benewah Creek is a tributary to Benewah Lake, which is part of Lake Coeur d'Alene. Therefore, migratory stocks would be adfluvial. Migration trap data for Benewah Creek did not show proof of an adfluvial population of cutthroat trout. Age class data showed most of the cutthroat trout captured in Benewah Creek to be between O-3 years of age. Whether these are resident fish or adfluvial fish that are emigrating is undetermined. Presence of an adfluvial population of cutthroat trout in Benewah Creek was indicated by back calculated lengths and age class structures of the older fish captured. Growth rates of cutthroat trout were similar until age 3+ (Table 4.7). Those older age classes captured had growth rates indicative of adfluvial cutthroat trout.

4.2.3. Alder Creek

Alder Creek discharges into the St. Maries River, therefore any migratory stocks present would be fluvial. However, stocks were not determined as fluvial or resident since no migration traps were installed. The possibility of an fluvial stock may exist in the lower section based on historical personal testimonies of tribal elders. Above the falls it is highly questionable whether a fluvial stock exists because of the barrier that exists in the form of a waterfall. Therefore, fish captured in the middle and upper reaches, both located above the falls, are thought to be resident fish. Back calculated lengths were calculated for Alder Creek in 1991 and 1992. In 1991 no cutthroat trout were collected below the falls. 1992 growth rates, when compared to growth rates of documented fluvial stocks, were smaller, indicative of resident stocks (Table 4.7). In 1992, cutthroat trout were captured below the falls and growth rates were larger after year two indicative of a fluvial population.

4.2.4. Evans Creek

Back calculated lengths, age class structure (see section 3.2.1, Table 3.45), and migration trap data indicated Evans Creek contains a healthy population of resident west-slope cutthroat trout. Fluvial or adfluvial stocks could not be determined from the data collected.

4.3. Bull trout

Habitat conditions for bull trout were difficult to summarize since no bull trout were captured during the study. Bull trout have become functionally extinct in the lower St. Joe and Coeur d'Alene basins where the study tributaries were located. Bull trout still exist in the upper St. Joe River in unentered watersheds. Bull trout require more pristine conditions than cutthroat trout. Therefore, any improvement in cutthroat trout habitat would be beneficial to both trout species.

4.4. Conclusions

Habitat degradation and low survival rates of cutthroat trout to maturity have contributed to depressed populations of cutthroat trout within the Coeur d'Alene System. It would likely take several decades to rebuild these populations solely by natural reproduction once habitat improvement has been completed. Trout production levels in all tributaries, except Evans Creek, are well below optimal seeding levels. In conjunction with habitat restoration, seeding the tributaries is the best suited approach to increase population levels of cutthroat trout. The Coeur d'Alene Tribe identified two biological objectives for their fishery 1). Restore native populations of cutthroat and bull trout, while maintaining genetic integrity, and 2.) Increase subsistence harvest. In order to accomplish these goals four objectives were determined 1.) protect existing stocks, 2.) restore degraded habitat, 3.) expand current populations and, 4.) re-establish self-sustaining populations of cutthroat and bull trout.

In order to protect existing stocks of cutthroat and bull trout, the Coeur d'Alene Indian Tribe's first recommendation was to close fishing during spawning migration periods. The Idaho Department of Fish and Game (IDFG) has imposed special fishing regulations on cutthroat trout in the Couer d'Alene System. Closure of cutthroat fishing has already been established during spawning periods. IDFG has also closed all bull trout fishing in the Lake Coeur d'Alene system. The tribe fully supports all of these decisions. However, the Coeur d'Alene Tribe upon reviewing their hunting/fishing regulations has closed cutthroat and bull trout harvest by both tribal members and non-Indians in waters of the reservation. These closures will protect declining stocks from mortality due to angler harvest during spawning migrations as well as rearing cutthroat and bull trout.

Our long term goal is for the tributaries to support self-sustaining populations of cutthroat and bull trout. In order to accomplish this the Coeur d'Alene Tribe recommends that necessary habitat enhancement measures take place before any other work is completed. Tributaries surveyed showed extensive damage due to land use practices which included agriculture, grazing and silvaculture. Problems encountered included eroding stream banks, massive sediment loading resulting in high embeddeness, insufficient canopy, instream and overhanging cover. Animal keeping practices within the system were also major problems associated with almost all drainages. Vehicular traffic within and crossing the stream channel were also common problems.

Since overharvest and habitat degradation have been major problems in the Coeur d'Alene System for a long period of time even with the protection measures previously mentioned, the current population of cutthroat and bull trout will probably not be sufficient for rapid repopulation of the tributaries to carrying capacity. Habitat degradation and low survival rates of cutthroat and bull trout fry have also contributed to depressed populations of these species. Most likely it will take several decades to rebuild these populations solely by natural reproduction. Consequently it will be necessary to supplement native populations to accomplish the goal of population expansion.

For the reasons mentioned above the third recommendation is for a low capital hatchery for cutthroat and bull trout on the Couer d'Alene Indian Reservation. The cutthroat and bull trout hatchery is only a short term plan to aid in re-establishing these populations and increasing substenence fishing.

The Coeur d'Alenes final recommendation is that all fishery enhancement projects (habitat improvements and supplementation efforts) be monitored for a five-year period after implementation to determine their effectiveness. The monitoring program should include:

1.) Creel survey to determine the number of angler hours, catch per unit effort by anglers, and catch and harvest rates for each species.

2.) Population estimates of both hatchery raised and wild cutthroat and bull trout to determine if populations increase owing to habitat enhancement and stocking

3.) Growth rates of hatchery and wild fish stocks.

4.) Abundance of preferred prey organisms to determine the effect of stocking different numbers of fish on the ecosystem.

5.) A mark recapture study with various ages of hatchery released cutthroat and bull trout to determine if they remain in the tributaries or migrate into Lake Coeur d'Alene. Assess effectiveness of different locations, age or size at release and time of release for outplanting.

6.) Periodic assessments and quantification of habitat to ensure continuance of habitat improvement benefits.

Monitoring of hatchery outplanting and habitat improvements will provide important knowledge upon which future management decisions can be based.

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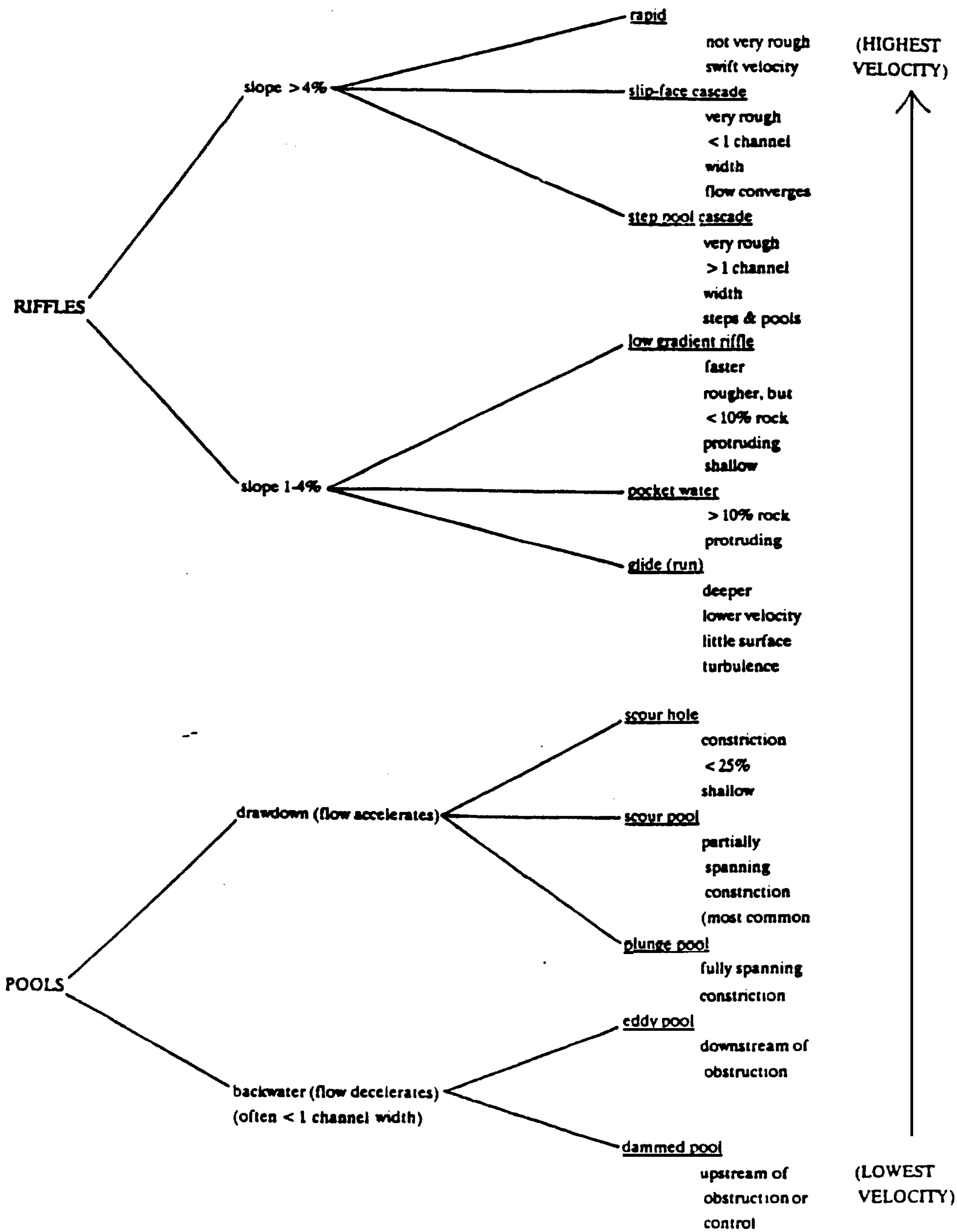
APPENDIX A

KEY TO CHANNEL UNITS (from Sullivan)



SYNOPTICAL KEY To CHANNEL UNITS

This key is designed to assist in the identification of channel units in third sod fourth order stream as they appear during baseflow conditions. Although most of the units have similar chrractetistics as those described at the more extreme high or low flows, the depth and water surface characteristics, in particular, may vary. The relationship between units is illustrated in Pigure 5.12, pg 97.

Is Water flowing or standing in smaller channels (braids) thet are connected to the main chsnoel vithia the active floodplain. These smaller reaches may have both pools rod riffler (described below) although they are usually of smaller proportioo then main channel units. The cheooels that are inundated during higher flows are often discoaoected from the flow at lower flows lerviog pools of standing water along the channel margins.

SECONDARY CHANNEL

(SIDE CHANNEL)

Lb Water flowing in a well-defined permanent channel

2a Water is shallower and faster than the reach • ver8ge; steep water surface slope

RIFFLE UNITS

(macro-units), lead 3a

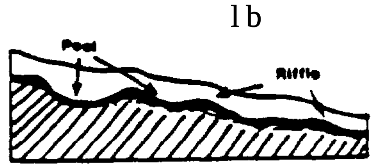
2b Water is deeper and • louer than the reach average; gentle water surface slope

POOL UNITS

(macro-units) , lead 8a

Ia

1b



RIFFLE UNITS
(Macro-units)

Riffle units are relatively shallow and fast with steep channel gradients; flow is swift and the water surface is rough or wavy; substrate is generally gravel to cobble in rite; water surface may be broken by rocks protruding through the surface

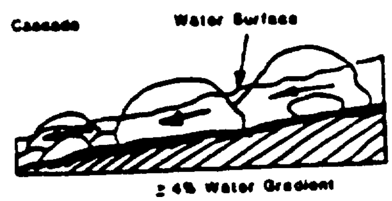
3a Channel and water surface slopes greater than or approximately equal to 0.04; flow uneven or turbulent with whitewater caused by local standing wave •

CASCADE UNITS
(woo-units), lead 4a

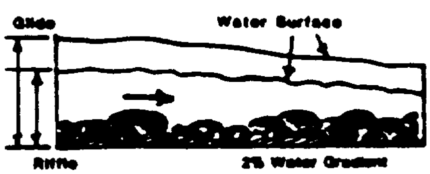
3b Channel gradient less than 4% but greater than 1%; flow is cveo but turbulent with little white water

RIPPLE UNITS
(meso-units), lead 7a

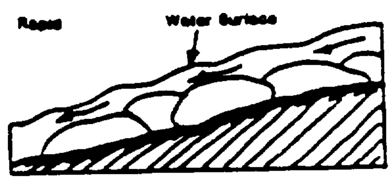
3a



3b



3a

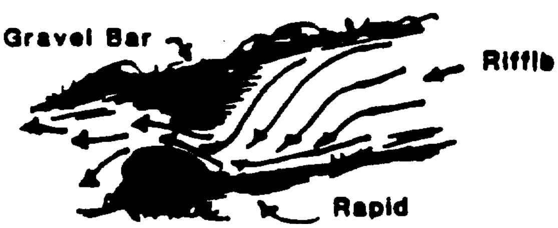


CASCADE UNITS

A meso-unit class of channel units with channel slopes greater than or approximately equal to 4%. Cascade units tend to be associated with obstructions that constrict stream flow, although in smaller, steeper streams they can occur in unconstricted channels.

4a Few rocks protrude through the flow although flow is swift and very turbulent; often found upstream of channel constrictions where gravel bars slope diagonally across the channel funneling streamflow into narrow troughs along one bank; water surface streams and is opaque but whitewater is not common; may have standing waves present at the downstream end of the unit at the junction of the unit and the head of the pool where flow passes channel obstructions.

<u>RAPIDS</u>



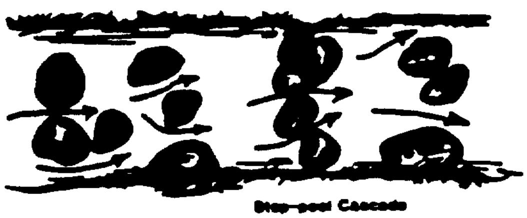
4b Rocks protrude through the flow on 10% of more or the surface area of the unit giving these units high relative roughness and causing considerable pooling of water behind the rocks; whitewater scattered throughout the unit at most flows

5a Relatively long channel units (length greater than 1 channel width); tend to occur where valley slopes are greater than 3.5% but usually not steeper than 6%; generally in smaller streams (third order or smaller) but are also found in larger streams at valley constrictions (bedrock outcrops, earthflows, debris jams etc.); characterized by a series of boulder bars, composed of strings of boulders wedged together across all or part of the channel, or logs, that form small falls and create a series of steps spaced at 1 channel width or less and separated by short, shallow pools

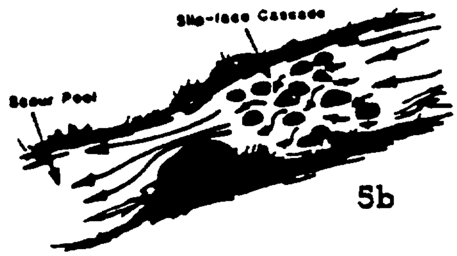
<u>STEP-POOL CASCADES</u>

5b Shorter units, less than or equal to 1 channel width, that form upstream of local constrictions such as logs, debris jams, bedrock outcrops, etc.; often the downstream end of the unit cuts across the channel at a 45° angle; occur on the steep, downstream face of gravel bars positioned at the channel obstructions; flow converges through the unit and channel width decreases approximately 25% from the upstream to downstream end of the unit

<u>SLIP-FACE CASCADES</u>



5a



5b

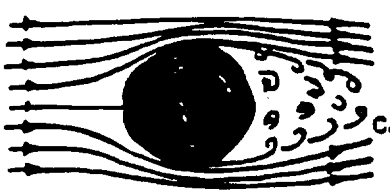
6a Small pools on the downstream side of the protruding rocks surrounded by swiftly flowing water

Cascade pools

(also referred to as pocket water)

6b Swiftly flowing water between the protruding rocks

Cascade-mainstream



6a

6b

RIFFLES (MESO-UNITS)

Channel gradient between 1 and 4%; generally composed of gravel to cobble substrate with little of the surface area of the unit made up of large rocks protruding through the flow (although these units often appear rough at very low flows); uniform flow (banks parallel through the length of the unit); standing waves generally absent; moderate to swift velocity; moderate to shallow depth

7a Slower, smoothly flowing water with moderate depth; usually on the lower end of the range of channel gradient (between 1 and 2%); these units can occur anywhere in the stream where riffles may occur, but they most often occur at the transition between particularly elongated pools and the downstream riffle in the zone referred to as the tailout of the pool, but they are usually only identified at particularly elongated pools and therefore these units are not a common feature in small streams.

<u>GLIDE</u>

A unit with similar characteristics is common in larger streams (fourth order or larger).

Run

7b Swiftly flowing with depth shallow enough that submerged particles of the bed disturb the water surface (often producing a diamond-shaped pattern of surface waves) but generally do not protrude through the flow (0 to 10% of the surface area); channel gradient greater than 2% but less than 4%.

<u>LOW-GRADIENT RIFFLES</u>

Low-gradient riffles resemble cascades at the very low flows of the year since many boulders normally submerged become exposed. The 10% surface area cutoff point appears to be a reasonably good separating criteria, even at low flows, but unit slope can always be used to distinguish the two units.

POOL UNITS
(Macro-units)

Flow in pools is relatively deep and slow with gentle energy gradients; water surface is tranquil or slightly disturbed although not to the extent that the surface becomes opaque (some turbulence may occur at the head of the pool as flow passes through the constriction with which the pool is associated); substrate may vary in size from fines to boulders

8a Flow decelerates within the unit and the flow path is often lateral or vortical relative to the main stream

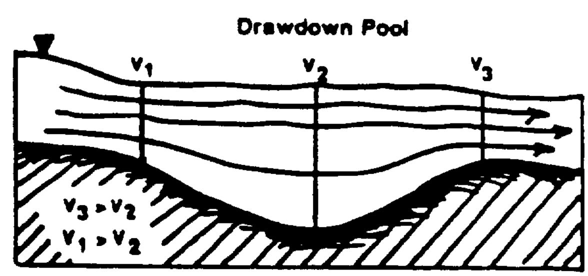
BACKWATER POOLS, LEAD 9A

8b Flow accelerates within the pool, speeding up at the downstream end where the depth decreases, and flow path follows the main stream

DRAWDOWN POOLS, LEAD 10A

8a

8b



BACKWATER POOLS (meso-unit)

Backwater pools are always associated with obstructions. Flow lines diverge from the downstream path and flow decelerates within the unit, moving perpendicular or lateral to the main flow; flow is characterized by decreasing velocity and decreasing water surface slope within the unit; units are often without distinct three-dimensional shapes and units are determined relative to the obstructions (not to the streambed); water surface slope less than 0.5%

9a Unit lies upstream of obstruction such as log, debris jam, etc.; unit is often found proximal to slip-face cascades where obstructions partially span the channel (at high flow water often backs up through the unit and drowns out the cascades); can be large (full channel width, several channel widths in length) or small (on the order of one square meter) depending on the degree to which the obstruction blocks the channel

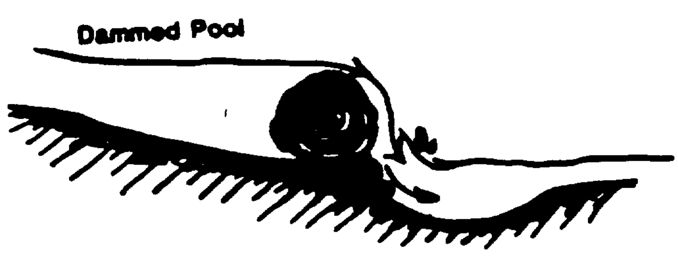
DAMMED POOL

9b Unit lies downstream of an obstruction; eddies formed by the obstruction are relatively large and generally border the thalweg on one side and the downstream edge of the channel on the other

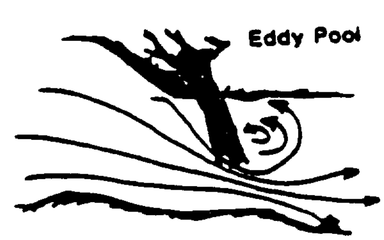
EDDY POOL

This pool type has been described as backwater pools by Bisson et al. (1982), but herein the term backwater pool will be applied only to the general category of pools in which flow decelerates.

9a



9b



DRAWDOWN POOLS

Pools associated with the thalweg of the channel. Flow is usually rapid where flow enters the upstream end of the pool, decelerates where it meets the slower body of water in the pool, but accelerates again at the shallowing downstream end of the pool; submerged jets of flow form at the head of the pool which radiates outward causing diverging flow and channel width from the upstream to downstream end of the pool; water surface slope greater than 0.5 % but less than 1.0%

10a Pool found downstream of an obstruction that spans at least three fourths of entire active channel but which lies within the top one half of the channel depth at bankfull discharge (indicated by the permanent vegetation line) but not above the bank; unit shape is shorter and deeper than other drawdown pools; often found downstream of a free overfall (water fall) where flow leaves the stream bed and plunges into the downstream pool

PLUNGE POOL

(Smaller plunge pools can occur along the sides of of the channel where obstructions block secondary channels.)

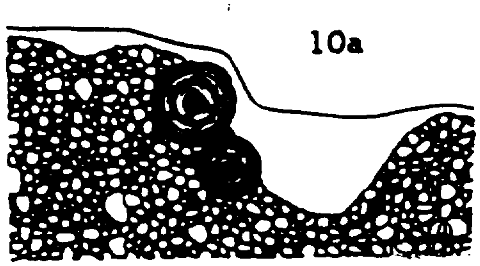
10a

10b

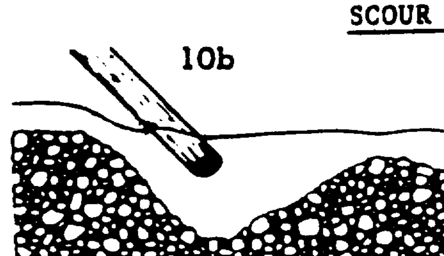
10b Pool found downstream of a partially-spanning channel obstruction that constricts the channel more than 25% but less than 100% of the bankfull width marked by the vegetation line (the maximum constriction that forms these units may be closer to 3/4 bankfull channel width); constrictions cause lateral scour as flow is directed sideways against the banks or vertical scour of the bed

SCOUR POOL

10a



10b



APPENDIX B

Table B.l. Frequency of occurence, total percent occurence, total area, percent area, and residual pool depth values for Valley Segment #1 for Lake Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	2	1.77	9.7	0.16	
Step pool cascade	0	0	0	0	
Slip face cascade	2	1.77	17.4	0.29	
Total Cascades	**4**	**3.54**	**27.1**	**0.45**	
Pocketwater	2	1.77	223.9	3.7	
Glide	34	30.09	1664.2	27.51	
Run	0	0	0	0	
Low gradient riffle	43	38.05	3285.8	54.32	
Total Riffles	79	**69.91**	5173.9	**85.53**	
Dammed pool	1	0.88	37.7	0.62	0.27
Eddy pool	3	2.65	57.7	0.95	0.48
Plunge pool	7	6.19	165.8	2.74	0.42
Scour pool	15	13.27	461.8	7.63	0.5
Scour hole	3	2.65	72.8	1.2	0.6
Beaver pond	0	0	0	0	0
Total Pools	**29**	**25.64**	**795.8**	**13.14**	**2.27**
Secondary channel	1	0.88	52.4	0.87	0.09
Grand Totals	**113**	**99.97**	**6049.2**	**99.99**	**2.36**

Table B.2. Summary report for Valley Segment # 1 of Lake Creek Watershed data collected during 1992.

Elevation	**652-681 m**
Total length	**1450.8 m**
Stream order	3
Mean stream gradient	0.8
Pool/riffle/cascade ratio	**31.4/1.91e-2/1**
Land use	
Forest	99.6%
Agriculture	
Livestock grazing	
Mining	
Wetland	
Other (includes residential,right of way, etc.)	0.4%
Vegetative type	
Decidious	1.8%
Coniferous	
Mixed	**98.2%**
Seral stage	
Grass/forb	35.0%
Shrub	42.9%
Pole	16.8%
Young	
Mature	
Old growth	
Other	
x Canopy cover	**19.7 (O-99)**
# Woody debris	
Logs	234
Root wads	18

Table B.3. Frequency of occurrence, total percent occurence, total area, percent area, and residual pool depth values for Valley Segment #2 for Lake Creek during 1992.

Habitat Type	Frequency	% Frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	1	**1.33**	37.7	0.29	
Slip face cascade	1	1.33	20.1	0.16	
Total Cascades	**2**	2.66	57.8	0.45	
Pocketwater	27	36	9077.9	70.39	
Glide	12	16	669.3	5.19	
Run	0	0	0	0	
Low gradient riffle	15	20	2185.6	16.95	
Total Riffles	**54**	72	**11932.8**	**92.53**	
Dammed pool	0	0	0	0	0
Eddy pool	0	0	0	0	0
Plunge pool	1	1.33	28.9	0.22	0.27
Scour pool	16	21.33	609.3	4.72	0.44
Scour hole	0	0	0	0	0.6
Beaver pond	0	0	0	0	0
Total Pools	**17**	22.66	638.2	4.94	0.77
Secondary channel	2	2.67	268.1	2.08	0.12
Grand Totals	**75**	**99.99**	**12896.9**	**100**	**0.89**

Table 8.4. Summary report for Valley Segment # 2 of Lake Creek Watershed data collected during 1992.

Elevation	**681-731 m**
Total length	**2735.9 m**
Stream order	3
Mean stream gradient	2.0
Pool/riffle/cascade ratio	**15.6/2.07e-2/1**
Land use	
Forest	94.7%
Agriculture	
Livestock grazing	
Mining	1.3%
Wetland	
Other (includes residential,right of way, etc.)	4.0%
Vegetative type	
Decidious	
Coniferous	
Mixed	**98.7%**
Serai stage	
Grass/forb	
Shrub	
Pole	
Young	
Mature	98.7%
Old growth	
Other	1.3%
x Canopy cover	**16.5** (O-33)
# Woody debris	
Logs	10
Root wads	0

Table B.5. Frequency of occurrence, total percent occurrence, total area, percent area, and residual pool depth values for Valley Segment #3 for Lake Creek during 1992.

Habitat Type	Frequency	% Frequency	Total Area (Sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	0	0	0	0	
Slip face cascade	0	0	0	0	
Total Cascades	**0**	**0**	**0**	**0**	
Pocketwater	0	0	0	0	
Glide	51	31.29	8101.1	42.32	
Run	0	0	0	0	
Low gradient riffle	71	43.56	7952.6	41.54	
Total Riffles	122	74.85	16053.7	83.86	
Dammed pool	1	0.61	211.1	1.1	0.91
Eddy pool	0	0	0	0	0
Plunge pool	0	0	0	0	0.27
Scour pool	36	22.09	2585.2	13.5	0.55
Scour hole	1	0.61	132.4	0.69	0.82
Beaver pond	0	0	0	0	0
Total Pools	38	23.31	2928.7	**15.29**	2.55
Secondary channel	3	1.84	162.1	0.85	0.38
Grand Totals	**163**	**100**	**19144.5**	**100**	**2.93**

Table B.6. Summary report for Valley Segment # 3 of Lake Creek Watershed data collected during 1992.

Elevation	731-765 m	
Total length	4171.8 m	
Stream order	3	
Mean stream gradient	1.4	
Pool/riffle/cascade ratio	0.19/1/0	
Land use		
Forest	89.6%	
Agriculture	9.2%	
Livestock grazing	9.2%	
Mining		
Wetland		
Other (includes residential,right of way, etc.)	1.2%	
Vegetative type		
Decidious		
Coniferous		
Mixed	98.9%	
Serai stage		
Grass/forb	9.2%	
Shrub		
Pole		
Young		
Mature	89.6%	
Old growth		
Other	1.2%	
x Canopy cover	0	(0-0)
# Woody debris		
Logs	19	
Root wads	1	
Valley type	M I	

Table 8.7. Frequency of occurrence, total percent occurence, total area, percent area, and residual pool depth values for Valley Segment #4 for Lake Creek during 1992.

Habitat Type	Frequency	% Frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	0	0	0	0	
Slip face cascade	0	0	0	0	
Total Cascades	**0**	**0**	**0**	**0**	
Pocketwater	0	0	0	0	
Glide	19	44.19	12358.5	76.48	
Run	0	0	0	0	
Low gradient riffle	12	27.91	1729.5	10.7	
Total Riffles	**31**	**72.1**	**14088**	**87.1 8**	
Dammed pool	4	9.3	408.6	2.53	0.53
Eddy pool	0	0	0	0	0
Plunge pool	0	0	0	0	0.27
Scour pool	6	13.95	1585	9.81	0.68
Scour hole	2	4.65	76.8	0.48	0.59
Beaver pond	0	0	0	0	0
Total Pools	**12**	**27.9**	**2070.4**	**12.82**	**2.07**
Secondary channel	0	0	0	0	0
Grand Totals	**4 3**	**100**	**16158.4**	**100**	**2.07**

Table 8.8. Summary report for Valley Segment # 4 of Lake Creek Watershed data collected during 1992.

Elevation	765-780 m	
Total length	5074.6 m	
Stream order	3	
Mean stream gradient	1.3	
Pool/riffle/cascade ratio	0.15/1/0	
Land use		
Forest	7.0%	
Agriculture	77.9%	
Livestock grazing		
Mining		
Wetland		
Other (includes residential,right of way, etc.)	1.2%	
Vegetative type		
Decidious		
Coniferous		
Mixed	100.0%	
Serai stage		
Grass/forb		
Shrub	51.2%	
Pole		
Young	48.8%	
Mature		
Old growth		
Other		
x Canopy cover	0	(0-0)
# Woody debris		
Logs	53	
Root wads	1	
Valley type	M2	

Table B.9. Frequency of occurrence, total percent occurence, total area, percent area, and residual pool depth values for Bozard Creek during 1992.

Habitat Type	Frequency	% Frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	0	0	0	0	
Slip face cascade	0	0	0	0	
Total Cascades	**0**	**0**	**0**	**0**	
Pocketwater	0	0	0	0	
Glide	**3**	**33.33**	**2077.2**	**32.44**	
Run	0	0	0	0	
Low gradient riffle	5	**55.56**	4319.5	**67.46**	
Total Riffles	**8**	**88.89**	**6396.7**	**99.9**	
Dammed pool	0	0	0	0	0
Eddy pool	0	0	0	0	0
Plunge pool	1	11.11	**6.7**	0.1	**0.27**
Scour pool	0	0	0	0	0
Scour hole	0	0	0	0	0
Beaver pond	0	0	0	0	0
Total Pools	1	**11.11**	**6.7**	**0.1**	**0.27**
Secondary channel	0	0	0	0	0
Grand Totals	**9**	**100**	**6403.4**	**100**	**0.27**

Table B.lO. Summary report for Bozard Creek Watershed data collected during 1992.

Elevation	**780-787. m**
Total length	**3041.6 m**
Stream order	2
Mean stream gradient	2.0
Pool/riffle/cascade ratio	**1.05e-3/1/0**
Land use	
Forest	66.7%
Agriculture	33.3%
Livestock grazing	33.3%
Mining	
Wetland	
Other (includes residential,right of way, etc.)	
Vegetative type	
Decidious	
Coniferous	
Mixed	100.0%
Serai stage	
Grass/forb	
Shrub	100.0%
Pole	
Young	
Mature	
Old growth	
Other	
x Canopy cover	**0 (0-0)**
# Woody debris	
Logs	**0**
Root wads	0
Valley type	M 2

Table B.11. Frequency of occurrence, total percent occurence, total area, percent area, and residual pool depth values for Valley Segment #1 for West Lake Creek during 1992.

Habitat Type	Frequency	% Frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	0	0	0	0	
Slip face cascade	0	0	0	0	
Total Cascades	**0**	**0**	**0**	**0**	
Pocketwater	0	0	0	0	
Glide	9	39.13	1337.8	37.4	
Run	0	0	0	0	
Low gradient riffle	9	39.13	2182.5	61.01	
Total Riffles	**18**	78.26	3520.3	**98.41**	
Dammed pool	0	0	0	0	0
Eddy pool	0	0	0	0	0
Plunge pool	1	4.35	24.7	0.69	0.3
Scour pool	4	17.39	32.1	0.9	0.46
Scour hole	0	0	0	0	0
Beaver pond	0	0	0	0	0
Total Pools	**5**	**21.74**	56.8	0.78	0.49
Secondary channel	0	0	0	0	0
Grand Totals	**23**	**100**	**3577.1**	**99.19**	**0.49**

Table 8.12. Summary report for Valley Segment #1 of West Fork Lake Creek Watershed data collected during 1992.

Elevation	**780-793 m**
Total length	**2975.5 m**
Stream order	2
Mean stream gradient	**1 .o**
Pool/riffle/cascade ratio	**1.62e-2/1/0**
Land use	
Forest	30.4%
Agriculture	
Livestock grazing	69.6%
Mining	
Wetland	
Other (includes residential,right of way, etc.)	
Vegetative type	
Decidious	
Coniferous	
Mixed	100.0%
Seral stage	
Grass/forb	**60.9%**
Shrub	30.4%
Pole	8.7%
Young	
Mature	
Old growth	
Other	
x Canopy cover	**0 (0-0)**
# Woody debris	
Logs	25
Root wads	0
Valley type	M 2

Table B.13. Frequency of occurrence, total percent occurrence, total area, percent area, and residual pool depth values for Valley Segment #2 for West Lake Creek during 1992.

Habitat Type	Frequency	% Frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	0	0	0	0	
Slip face cascade	0	0	0	0	
Total Cascades	**0**	**0**	**0**	**0**	
Pocketwater	1	9.09	205.5	8.9	
Glide	0	0	0	0	
Run	0	0	0	0	
Low gradient riffle	5	45.45	2055.5	89.03	
Total Riffles	**6**	54.54	2261	97.93	
Dammed pool	0	0	0	0	0
Eddy pool	0	0	0	0	0
Plunge pool	4	36.36	30.9	1.34	0.2
Scour pool	1	9.09	16.7	0.72	0.49
Scour hole	0	0	0	0	0
Beaver pond	0	0	0	0	0
Total Pools	5	45.45	47.6	2.06	0.51
Secondary channel	0	0	0	0	0
Grand Totals	11	**99.99**	2308.6	99.99	**0.51**

Table B.14. Summary report for Valley Segment # 2 of West Fork Lake Creek Watershed data collected during 1992.

Elevation	793-841 m	
Total length	1424.9 m	
Stream order	2	
Mean stream gradient	1 .o	
Pool/riffle/cascade ratio	2.11e-2/1	
Land use		
Forest	100.0%	
Agriculture		
Livestock grazing		
Mining		
Wetland		
Other (includes residential,right of way, etc.)		
Vegetative type		
Decidious		
Coniferous		
Mixed	100.0%	
Seral stage		
Grass/forb		
Shrub	45.5%	
Pole		
Young	54.5%	
Mature		
Old growth		
Other		
x Canopy cover	0.0	(0-0)
# Woody debris		
Logs	3	
Root wads	0	

Table B.15. Frequency of occurrence, total percent occurrence, total area, percent area and residual pool depth values for Valley Segment #1 for Benewah Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	2	5.71	2727.9	30.65	
Slip face cascade	0	0	0	0	
Total Cascades	2	5.71	2727.9	30.65	
Pocketwater	5	14.29	2619.7	29.44	
Glide	8	22.86	1635.2	18.38	
Run	0	0	0	0	
Low graident riffle	10	28.57	1280.1	14.38	
Total Riffles	23	65.72	5535	62.2	
Dammed pool	2	5.71	137	1.54	0.67
Eddy pool	0	0	0	0	0
Plunge pool	1	2.86	42.3	0.47	0.61
Scour pool	3	8.57	205.7	2.31	0.61
Scour hole	3	8.57	136.1	1.53	0.46
Beaver pond	0	0	0	0	0
Total Pools	9	25.71	521.1	5.85	2.35
Secondary channel	1	2.86	115.1	1.29	0.06
Grand Totals	35	100	8899.1	99.99	2.41

Table 8.16. Summary report for Valley Segment # 1 of Benewah Creek Watershed data collected during 1992.

Elevation	683-713 m
Total length	1904.2 m
Stream order	4
Mean stream gradient	3.0
Pool/riffle/cascade ratio	.233/2.029/1
Land use	
Forest	5.6%
Agriculture	
Livestock grazing	25.0%
Mining	
Other (includes residential,right of way, etc.)	69.4%
Vegetative type	
Decidious	69.4%
Coniferous	16.7%
Mixed	13.9%
Serai stage	
Grass/forb	27.8%
Shrub	52.8%
Pole	2.8%
Young	
Mature	16.7%
Old growth	
Other	
x Canopy cover	3.11 (O-28)
# Woody debris	
Logs	17
Root wads	1

Table B.17. Frequency of occurrence, total percent occurrence, total area, percent area, and residual pool depth values for Valley Segment #2 for Benewah Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	8	5.93	562.4	3.81	
Slip face cascade	13	9.63	310	2.1	
Total Cascades	21	15.56	872.4	5.91	
Pocketwater	42	31.11	11288.6	76.45	
Glide	8	5.93	409.9	2.78	
Run	0	0	0	0	
Low graident riffle	20	14.81	1425.7	9.66	
Total Riffles	70	51.85	13124.2	88.89	
Dammed pool	18	13.33	415.9	2.82	0.42
Eddy pool	1	0.74	1.2	>.01	0.15
Plunge pool	4	2.96	65.4	0.44	0.39
Scour pool	9	6.67	170.5	1.15	0.46
Scour hole	12	8.89	116.3	0.79	0.31
Beaver pond	0	0	0	0	0
Total Pools	44	32.59	769.3	5.2	1.73
Secondary channel	0	0	0	0	0
Grand Totals	135	100	14765.9	100	1.73

Table 8.18. Summary report for Valley Segment #2 of Benewah Creek Watershed data collected during 1992.

Elevation	713-732 m
Total length	1871.5 m
Stream order	4
Mean stream gradient	3.6
Pool/riffle/cascade ratio	.8/15.0/1
Land use	
Forest	65.0%
Agriculture	
Livestock grazing	
Mining	1.1%
Wetland	1.5%
Other (includes residential,right of way, etc.)	9.5%
Vegetative type	
Decidious	5.8%
Coniferous	8.8%
Mixed	85.4%
Seral stage	
Grass/forb	7.7%
Shrub	58.0%
Pole	1.8%
Young	4.0%
Mature	26.3%
Old growth	0.7%
Other	1.5%
x Canopy cover	6.64 (O-76)
# Woody debrls	
Logs	26
Root wads	3

Table B.19. Frequency of occurrence, total percent occurrence, total area, percent area and residual pool depth values for Valley Segment # 3 for Benewah Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	3	2.01	207.2	0.85	
Slip face cascade	28	18.79	1659.4	6.84	
Total Cascades	31	20.8	1866.6	7.69	
Pocketwater	35	23.49	14606.6	60.18	
Glide	14	9.4	2244.3	9.25	
Run	0	0	0	0	
Low graident riffle	25	16.78	4089.2	16.85	
Total Riffles	74	49.67	20940.1	86.28	
Dammed pool	10	6.71	425.4	1.75	0.42
Eddy pool	1	0.67	5.9	0.02	0
Plunge pool	0	0	0	0	0.39
Scour pool	16	10.74	787.2	3.24	0.37
Scour hole	17	11.41	245.7	1.01	0.27
Beaver pond	0	0	0	0	0
Total Pools	44	29.53	1464.2	6.02	1.45
Secondary channel	0	0	0	0	0
Grand Totals	149	100	24270.9	99.99	1.45

Table 8.20. Summary report for Valley Segment #3 of Benewah Creek Watershed data collected during 1992.

Elevation	732-793 m
Total length	3546.4 m
Stream order	4
Mean stream gradient	2.4
Pool/riffle/cascade ratio	.8/11.2/1
Land use	
Forest	38.7%
Agriculture	25.6%
Livestock grazing	
Mining	
Wetland	3.6%
Other (includes residential,right of way, etc.)	32.1%
Vegetative type	
Decidious	37.7%
Coniferous	1.4%
Mixed	60.9%
Serai stage	
Grass/forb	26.5%
Shrub	57.3%
Pole	2.0%
Young	7.0%
Mature	7.3%
Old growth	
Other	
x Canopy cover	4.33 (O-70)
# Woody debris	
Logs	4
Root wads	5
Bank cutting	3/659 m
Side channels	2168.3 m

Table 8.21. Frequency of ocurrence, total percent occurrence, total area, percent area and residual pool depth values for Valley Segemtn #4 for Benewah Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	0	0	0	0	
Slip face cascade	20	3.93	527.3	1.08	
Total Cascades	**20**	**3.93**	**527.3**	**1.08**	
Pocketwater	3	0.59	1083.6	2.21	
Glide	35	6.88	5990.2	12.22	
Run	0	0	0	0	
Low graident riffle	140	27.5	13787.5	28.13	
Total Riffles	**178**	**34.97**	**20861.3**	**42.56**	
Dammed pool	16	3.14	2534.3	5.17	0.6
Eddy pool	4	0.79	30.5	0.06	0.27
Plunge pool	3	0.59	67.1	0.14	0.64
Scour pool	241	47.35	14812.4	30.22	0.52
Scour hole	30	5.89	354.2	0.72	0.27
Beaver pond	17	3.34	9827.2	20.05	1.11
Total Pools	**311**	**61.1**	**27625.7**	**56.36**	**3.41**
Secondary channel	0	0	0	0	0
Grand Totals	**509**	**100**	**49014.3**	**100**	**3.41**

Table 8.22. Summary report for Valley Segment #4 of Benewah Creek Watershed data collected during 1992.

Elevation	793-838 m
Total length	7914.7 m
Stream order	4
Mean stream gradient	0.8
Pool/riffle/cascade ratio	52.4/39.6/1
Land use	
Forest	1.4%
Agriculture	
Livestock grazing	97.4
Mining	
Wetland	
Other (includes residential,right of way, etc.)	1.2%
Vegetative type	
Decidious	92.9%
Coniferous	
Mixed	3.7%
Serai stage	
Grass/forb	54.9%
Shrub	44.0%
Pole	
Young	
Mature	
Old growth	
Other	
x Canopy cover	5.05 (O-99)
# Woody debris	
Logs	453
Root wads	12
Bank cutting	3/2678 m
Side Channels	251906.9 m

Table 8.23. Frequency of occurrence, total percent occurrence, total area, percent area and residual pool depth values for Valley Segment #5 for Benewah Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	3	3.41	11.7	0.11	
Slip face cascade	0	0	0	0	
Totals Cascades	3	3.41	11.7	0.11	
Pocketwater	0	0	0	0	
Glide	24	27.27	3161.5	30.34	
Run	0	0	0	0	
Low graident riffle	36	40.91	4436.7	42.58	
Total Riffles	60	68.18	7598.2	72.92	
Dammed pool	4	4.55	1723.5	16.54	1.28
Eddy pool	0	0	0	0	0
Plunge pool	0	0	0	0	0
Scour pool	18	20.45	1001.4	9.61	0.66
Scour hole	0	0	0	0	0
Beaver pond	0	0	0	0	0
Total Pools	22	25	2724.9	26.15	1.94
Secondary channel	3	3.41	85.6	0.82	0.13
Grand Totals	88	100	10420.4	100	2.07

Table 8.24. Summary report for Valley Segment #5 of Benewah Creek Watershed data collected during 1992.

Elevation	838-854 m
Total length	4369 m
Stream order	4
Mean stream gradient	1.5
Pool/riffle/cascade ratio	.002/.006/l
Land use	
Forest	15.9%
Agriculture	1.1%
Livestock grazing	76.7%
Mining	
Wetland	
Other (includes residential,right of way, etc.)	6.3%
Vegetative type	
Decidious	
Coniferous	
Mixed	100.0%
Seral stage	
Grass/forb	83.5%
Shrub	12.5%
Pole	
Young	
Mature	
Old growth	
Other	
x Canopy cover	0.0 (0-0)
# Woody debris	
Logs	157
Root wads	12

Table 8.25. Frequency of occurrence, total percent occurence, total area, percent area, and residual pool depth values for Valley Segment #1 for Evans Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step-pool cascade	0	0	0	0	
Slip-face cascade	2	3.45	96.9	1.09	
Total Cascades	2	3.45	96.9	1.09	
Pocketwater	0	0	0	0	
Glide	2	3.45	141.5	1.56	
Run	0	0	0	0	
Low gradient riffle	25	43.1	7364.6	62.46	
Total Riffles	27	46.55	7506.1	64.04	
Dammed Pool	2	3.45	42.3	0.47	0.26
Eddy pool	5	8.62	144.3	1.62	0.68
Plunge pool	0	0	0	0	0
Scour pool	19	32.76	1089.5	12.2	0.59
Scour hole	3	5.17	52.1	0.58	0.43
Beaver pond	0	0	0	0	0
Total Pools	29	50	1326.2	14.67	1.96
Sec. channel	0	0	0	0	0
Grand Totals	58	100	8931.2	100	1.96

Table 8.26. Summary report for Valley Segment # 1 of Evans Creek Watershed data collected during 1992.

Elevation	646-659 m
Total length	1808.3 m
Stream order	4
Mean stream gradient	2.0
Pool/riffle/cascade ratio	13/77/1
Land use	
Forest	
Agriculture	
Livestock grazing	100.0%
Mining	
Other (includes residential etc.)	
Vegetatlve type	
Decidious	94.8%
Coniferous	
Mixed	5.2%
Seral stage	
Grass/forb	95.7%
Shrub	4.3%
Pole	
Young	
Mature	
Old growth	
Other	
x Canopy cover	32.9 (O-72)
# Woody debris	
Logs	16
Root wads	8

Table 8.27. Frequency of occurrence, total percent occurence, total area,percent area, and residualpool depth values for Valley Segment #2 for Evans Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	4	6.25	71.7	2.17	
Step-pool cascade	1	1.56	7.8	0.24	
Slip-face cascade	2	3.13	63.8	1.93	
Total Cascades	7	10.94	143.3	4.34	
Poc ketwater	0	0	0	0	
Glide	0	0	0	0	
Run	0	0	0	0	
Low gradient riffle	31	48.44	2533.4	76.8	
Total Riffles	31	48.44	2533.4	76.8	
Dammed Pool	2	3.13	26.5	0.8	0.2
Eddy pool	0	0	0	0	0.68
Plunge pool	3	4.69	42.1	1.28	0.34
Scour pool	18	28.13	509.9	15.46	0.39
Scour hole	3	4.69	43.5	1.32	0.22
Beaver pond	0	0	0	0	0
Total Pools	26	40.64	622	18.86	1.65
Sec. channel	0	0	0	0	0
Grand Totals	64	100.02	3298.7	100	1.65

Table 8.28. Summary report for Valley Segment # 2 of Evans Creek Watershed data collected during 1992.

Elevation	658-695 m	
Total length	832.1 m	
Stream order	4	
Mean stream gradient	1.5	
Pool/riffle/cascade ratio	4/17/1	
Land use		
Forest	100.0%	
Agriculture		
Livestock grazing		
Mining		
Other (includes residential etc.)		
Vegetative type		
Decidious		
Coniferous		
Mixed	100.0%	
Seral stage		
Grass/forb		
Shrub		
Pole		
Young		
Mature	98.4	
Old growth	1.6	
Other		
x Canopy cover	61	(O-93)
# Woody debris		
Logs	58	
Root wads	3	

Table 8.29. Frequency of occurence, toal percent occurence, total area, percent area, and residual pool depth values for Valley Segment #3 for Evans Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Resldual pool depth (m)
Rapid	14	17.95	967.3	20.85	
Step-pool cascade	1	1.28	14.4	0.31	
Slip-face cascade	0	0	0	0	
Total Cascades	15	19.23	981.7	21.16	
Pocketwater	0	0	0	0	
Glide	0	0	0	0	
Run	0	0	0	0	
Low gradient riffle	23	29.49	2653.7	57.21	
Total Riffles	23	29.49	2653.7	57.21	
Dammed Pool	3	3.85	116.7	2.52	0.53
Eddy pool	0	0	0	0	0
Plunge pool	11	14.1	217.6	4.69	0.53
Scour pool	25	32.05	660.1	14.23	0.47
Scour hole	1	1.28	8.8	0.19	0.37
Beaver pond	0	0	0	0	0
Total Pools	40	51.28	1003.2	21.63	1.9
Sec. channel (SDC)	0	0	0	0	0
Grand Totals	78	100	4638.6	100	1.9

Table 8.30. Summary report for Valley Segment # 3 of Evans Creek Watershed data collected during 1992.

Elevation	695-732 m
Total length	1182.4 m
Stream order	4
Mean stream gradient	2.3
Pool/riffle/cascade ratio	1/2.7/1
Land use	
Forest	97.4%
Agriculture	
Livestock grazing	2.6%
Mining	
Other (includes residential etc.)	
Vegetative type	
Decidious	
Coniferous	
Mixed	100.0%
Seral stage	
Grass/forb	
Shrub	
Pole	
Young	
Mature	96.8
Old growth	3.2
Other	
x Canopy cover	66.0 (38-88)
# Woody debris	
Logs	30
Root wads	0

Table 8.31. Frequency of occurence, toal percent occurence, total area, percent area,and residualpool depth values for Valley Segment #4 for Evans Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	32	41.03	5482.8	80.37	
Step-pool cascade	5	6.41	357.1	5.23	
Slip-face cascade	0	0	0	0	
Total Cascades	37	47.44	5839.9	85.6	
Pocketwater	0	0	0	0	
Glide	0	0	0	0	
Run	0	0	0	0	
Low gradient riffle	3	3.85	223.7	3.28	
Total Riffles	3	3.85	223.7	3.28	
Dammed Pool	2	2.56	76.1	1.12	0.37
Eddy pool	4	5.13	21.4	0.31	0.38
Plunge pool	9	11.54	187.3	2.75	0.32
Scour pool	23	29.49	473.5	6.94	0.33
Scour hole	0	0	0	0	0
Beaver pond	0	0	0	0	0
Total Pools	38	48.72	758.3	11.12	1.4
Sec channel	0	0	0	0	0
Grand Totals	78	100.01	6821.9	100	1.4

Table 8.32. Summary report for Valley Segment # 3 of Evans Creek Watershed data collected during 1992.

Elevation	732-756 m
Total length	1676.7 m
Stream order	4
Mean stream gradient	3.0
Pool/riffle/cascade ratio	.1/.03/1
Land use	
Forest	97.4%
Agriculture	
Livestock grazing	2.6%
Mining	
Other (includes residential etc.)	
Vegetative type	
Decidious	
Coniferous	
Mixed	98.7%
Seral stage	
Grass/forb	
Shrub	
Pole	
Young	
Mature	97.4
Old growth	2.6
Other	
x Canopy cover	65.2 (42-87)
# Woody debris	
Logs	18
Root wads	0

Table 8.33. Frequency of occurence, total percent occurence, toal area, percent area, and residual pool depth values for Valley Segment #5 for Evans Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	8	50	1529.2	83.55	
Step-pool cascade	3	18.75	146.1	7.98	
Slip-face cascade	0	0	0	0	
Total Cascades	11	68.75	1675.3	91.53	
Pocketwater	0	0	0	0	
Glide	0	0	0	0	
Run	0	0	0	0	
Low gradient riffle	1	6.25	62	3.39	
Total Riffles	1	6.25	62	3.39	
Dammed Pool	0	0	0	0	0
Eddy pool	0	0	0	0	0
Plunge pool	2	12.5	34.5	1.89	0.21
Scour pool	2	12.5	58.4	3.19	0.3
Scour hole	0	0	0	0	0
Beaver pond	0	0	0	0	0
Total Pools	4	25	92.9	5.08	0.51
Sec channel	0	0	0	0	0
Grand Totals	16	100	1830.2	100	0.51

Table 8.34. Summary report for Valley Segment # 5 of Evans Creek Watershed data collected during 1992.

Elevation	756-759 m
Total length	343.8 m
Stream order	4
Mean stream gradient	2.8
Pool/riffle/cascade ratio	.05/.04/l
Land use	
Forest	93.8%
Agriculture	
Livestock grazing	6.3%
Mining	
Other (includes residential etc.)	
Vegetatlve type	
Decidious	
Coniferous	
Mixed	100.0%
Seral stage	
Grass/forb	
Shrub	
Pole	
Young	
Mature	93.8
Old growth	6.3
Other	
x Canopy cover	70.8 (62-81)
# Woody debris	
Logs	14
Root wads	0

Table 8.35. Frequency of occurrence, total percent occurrence, total area, percents area, and residual pool depth for Valley Segment #1 for Alder Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	1	1	28.8	0.0	
Step pool cascade	2	2.1	95.6	0.1	
Slip face cascade	0	0	0	0.0	
Total Cascades	3	3.1	124.4	0.1	
Pocketwater	18	18.6	41092.5	55.5	
Glide	9	9.3	2355	3.2	
Run	0	0	0	0.0	
Low graident riffle	26	26.8	16783.1	22.7	
Total Riffles	53	54.7	60230.6	81.4	
Dammed pool	6	6.2	6893.1	9.3	0
Eddy pool	0	0	0	0.0	0
Plunge pool	5	5.1	1343.6	1.8	0.85
Scour pool	27	27.8	5060.8	6.8	0.48
Scour hole	1	1	54.6	0.1	0.15
Beaver pond	0	0	0	0	0
Total Pools	39	40.1	13352.1	18	1.48
Secondary channel	3	3.1	365.7	0.5	0
Grand Totals	98	97.9	74072.8	100	1.48

Table 8.36. Summary report for Valley Segment #1 Alder Creek Watershed data collected during 1992.

Elevation	704-768 m
Total length	396.4 m
Stream order	3
Mean stream gradient	2.8
Pool/riffle/cascade ratio	2.8/29.1/1
Land use	
Forest	100.0%
Agriculture	
Livestock grazing	
Mining	
Wetland	
Other (includes residential,right of way, etc.)	
Vegetative type	
Decidious	3.1%
Coniferous	69.1%
Mixed	27.8%%
Seral stage	
Grass/forb	
Shrub	13.8%
Pole	
Young	57.1%
Mature	29.1%
Old growth	
Other	
x Canopy cover	40.8 (5-90)
# Woody debris	
Logs	115
Root wads	13

Table 8.37. Frequency of occurence, total percent occurence, total area, percent area, and residualpool depth values for Valley Segment #2 for Alder Creek, during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	5	4.03	311.7	2.76	
Slip face cascade	3	2.42	31	0.27	
Total Cascades	8	6.45	342.7	3.03	
Pocketwater	11	8.87	1185	10.48	
Glide	38	30.65	2523.1	22.31	
Run	0	0	0	0	
Low graident riffle	48	38.71	6278.5	55.52	
Total Riffles	97	78.23	9986.6	88.31	
Dammed pool	0	0	0	0	0
Eddy pool	0	0	0	0	0
Plunge pool	13	10.48	758.3	6.71	0.53
Scour pool	6	4.84	220.7	1.95	0.45
Scour hole	0	0	0	0	0
Beaver pond	0	0	0	0	0
Total Pools	19	15.32	979	8.66	0.98
Secondary channel	0	0	0	0	0
Grand Totals	124	100	11308.3	100	0.98

Table 8.38. Summary report for Valley Segment #2 Alder Creek Watershed data collected during 1992.

Elevatlon	768-817 m
Total length	2917.8 m
Stream order	3
Mean stream gradient	2.8
Pool/riffle/cascade ratio	2.8/29.1/1
Land use	
Forest	99.2%
Agriculture	
Livestock grazing	
Mining	
Wetland	
Other (includes residential,right of way, etc.)	0.8%
Vegetative type	
Decidious	8.1%
Coniferous	
Mixed	91.9%
Seral stage	
Grass/forb	16.9%
Shrub	56.5%
Pole	2.4%
Young	24.2%
Mature	
Old growth	
Other	
x Canopy cover	19.18 (O-99)
# Woody debris	
Logs	33
Root wads	4

Table B.39. Frequency of occurrence, total percent occurrence, total area, percent area, and residual pool depth for Valley Segment #3 for Alder Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	1	2.22	3.7	0	
Slip face cascade	2	4.44	49.1	1.24	
Total Cascades	3	6.66	52.8	1.24	
Pocketwater	0	0	0	0	
Glide	21	46.67	1361	34.42	
Run	0	0	0	0	
Low gradient riffle	19	42.22	2395.7	60.58	
Total Riffles	40	88.89	3756.7	95	
Dammed pool	0	0	0	0	0
Eddy pool	0	0	0	0	0
Plunge pool	1	2.22	126.3	3.2	0.55
Scour pool	1	2.22	18.6	0.47	0.18
Scour hole	0	0	0	0	0
Beaver pond	0	0	0	0	0
Total Pools	2	4.44	144.9	3.67	0.73
Secondary channel	0	0	0	0	0
Grand Totals	45	99.99	3954.4	99.91	0.73

Table 8.40. Summary report for Valley Segment # 3 of Alder Creek Watershed data collected during 1992.

Elevation	817 m
Total length	961.3 m
Stream order	3
Mean stream gradient	3.0
Pool/riffle/cascade ratio	2.7171 .2/1
Land use	
Forest	78.9%
Agriculture	
Livestock grazing	8.9%
Mining	
Wetland	
Other (includes residential,right of way, etc.)	12.2%
Vegetative type	
Decidious	77.8%
Coniferous	
Mixed	22.2%
Seral stage	
Grass/forb	26.7%
Shrub	68.9%
Pole	1.1%
Young	3.3%
Mature	
Old growth	
Other	
x Canopy cover	26.8 (O-95)
# Woody debris	
Logs	2
Root wads	1

Table 8.41. Frequency of occurrence, total percent occurrence, total area, percent area, and residual pool depth for Valley Segment #4 for Alder Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	1	0.31	6	0.02	
Slip face cascade	20	6.29	271.4	0.83	
Total Cascades	21	6.6	277.4	0.65	
Pocketwater	10	3.14	670.9	2.05	
Glide	86	27.04	8510.2	26	
Run	0	0	0	0	
Low graident riffle	118	37.11	14100.1	43.07	
Total Riffles	214	67.29	23281.2	71.12	
Dammed pool	23	7.23	5126.5	15.66	0.57
Eddy pool	0	0	0	0	0
Plunge pool	1	0.31	21.4	0.07	0.3
Scour pool	57	17.92	3743.8	11.44	0.5
Scour hole	0	0	0	0	0
Beaver pond	0	0	0	0	0
Total Pools	81	25.46	8891.7	27.17	1.37
Secondary channel	2	0.63	287.2	0.88	0.08
Grand Totals	318	99.98	32737.5	94.02	1.45

Table 8.42. Summary report for Valley Segment # 4 of Alder Creek Watershed data collected during 1992.

Elevation	817-902 m
Total length	7534.5 m
Stream order	3
Mean stream gradient	2.3
Pool/riffle/cascade ratio	33/84/1
Land use	
Forest	65.8%
Agriculture	
Livestock grazing	22.0%
Mining	
Wetland	
Other (includes residential,right of way, etc.)	12.2%
Vegetative type	
Decidious	6.0%
Coniferous	3.1%
Mixed	90.9%
Seral stage	
Grass/forb	10.8%
Shrub	51.9%
Pole	
Young	15.6%
Mature	21.7
Old growth	
Other	
x Canopy cover	46.3 (O-94)
# Woody debris	
Logs	147
Root wads	30

Table 8.43. Frequency of occurrence, total percent occurrence, total area, percent area, and residual pool depth for Valley Segment #1 for North Fork Alder Creek during 1992.

Habitat Type	Frequency	% frequency	Total Area (sq. meters)	% Area	Residual pool depth (m)
Rapid	0	0	0	0	
Step pool cascade	0	0	0	0	
Slip face cascade	0	0	0	0	
Total Cascades	0	0	0	0	
Pocketwater	0	0	0	0	
Glide	11	52.38	721.3	22.18	
Run	0	0	0	0	
Low graident riffle	9	42.86	250 1.4	76.91	
Total Riffles	20	95.24	3222.7	99.09	
Dammed pool	0	0	0	0	0
Eddy pool	0	0	0	0	0
Plunge pool	1	4.76	29.5	0.91	0.85
Scour pool	0	0	0	0	0
Scour hole	0	0	0	0	0
Beaver pond	0	0	0	0	0
Total Pools	1	4.76	29.5	0.91	0.85
Secondary channel	0	0	0	0	0
Grand Totals	21	100	3252.2	100	0.85

Table B.44. Summary report for Valley Segment # 1 of North Fork Alder Creek Watershed data collected during 1992.

Elevation	817-962 m	
Total length	?	
Stream order	2	
Mean stream gradient	2.0	
Pool/riffle/cascade ratio	9.15e-3/1	
Land use		
Forest		
Agriculture		
Livestock grazing	100.0%	
Mining		
Wetland		
Other (includes residential,right of way, etc.)		
Vegetative type		
Decidious	85.7%	
Coniferous		
Mixed	9.5%	
Seral stage		
Grass/forb	100.0%	
Shrub		
Pole		
Young		
Mature		
Old growth		
Other		
x Canopy cover	0.0	(0-0)
# Woody debrls		
Logs	0	
Root wads	0	

APPENDIX C

Table C.1. Stream reach inventory and channel stability evaluation for the lower reach of Lake Creek, May 13, 1992.

	Stability Indicators by Classes							
# Item rated	Excellent		Good		Poor		Fair	
1 Land form slope	Bank slope gradient <30%	2	Bank slope gradient 30-40%		Bank slope gradient 40-60%		Bank slope gradient 60%	
2 Mass Wasting or Failure or potential)	No evidence of past or any potential for future mass wasting into channel.	3	Infrequent and/or very small. Mostly healed over. Low future potential.		Moderate frequency and size, with some raw spots eroded by water during high flows.		Frequent or large, causing sediment nearly yearlong or imminent danger of same.	
3 Debris Jam Potential	Essentially absent from immediate channel area.		Present but mostly small twigs and limbs.		Present, volume and size are both increasing.	6	Moderate to heavy amounts, predominantly larger sizes.	
4 Vegetative Bank Protection	90%+ plant density. Vigor and variety suggests a deep, dense, soil binding, root mass.		70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.		50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	9	<50% density plus fewer species and less vigor indicate poor, discontinuous, and shallow root mass.	
5 Channel Capacity	Ample for present plus some increases. Peak flows contained W/D ratio <7.		Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8 to 15.	2	Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.		Inadequate. Overbank flows common. W/D ratio >25.	
6 Bank Rock Content	65%+ with large, angular, boulders 12"+ numerous.		40-65%, mostly small boulders to cobbles 6-12".	4	20-40%, with most in the 3-6" diameter class.		<20% rock fragments of gravel sizes, 1-3" or less.	
7 Obstructions Flow Deflectors Sediment Traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable.	2	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.		Moderately frequent, moderately unstable obstructions and deflectors move with high water causing bank cutting and filling of pools.		Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	
8 Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.		Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".	6	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.		Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	
9 Deposition	Little or no enlargement of channel or point bars.	4	Some new increase in bar formation, mostly from coarse gravels.		Moderate deposition of new gravel and coarse sand on old and some new bars.		Extensive deposits of predominantly fine particles. Accelerated bar development.	
10 Rock Angularity	Sharp edges and corners, plane surfaces roughened.		Rounded corners and edges, surfaces smooth and flat.	2	Corners and edges well rounded in two dimensions.		Well rounded in all dimensions, surfaces smooth.	
11 Brightness	Surfaces dull, darkened, or stained, Generally not "bright".		Mostly dull, but may have up to 35% bright surfaces.	2	Mixture, 50-50% dull and bright, ±15% ie. 35-65%.		Predominantly bright, 65%+ exposed or scoured surfaces.	
12 Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	2	Moderately packed with some overlapping.		Mostly a loose assortment with no apparent overlap.		No packing evident. Loose assortment, easily moved.	
13 Bottom Size Distribution and Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	4	Distribution shift slight. Stable materials 50-80%.		Moderate change in sizes. Stable materials 20-50%.		Marked distribution change. Stable materials 0-20%.	
14 Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	6	5-30% affected. Scour at constrictions and steepened grades. Some deposition in pools.		30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.		More than 50% of the bottom in a state of flux or change nearly yearlong.	
15 Clinging Aquatic Vegetation (Moss and Algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too.		Common. Algal forms in low velocitiy and pool areas. Moss here too and swifter waters.		Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	
	Excellent column total	23	Good column total	16	Fair column total	18	Poor column total	0

Table C.2. Stream reach inventory and channel stability evaluation for the middle reach of Lake Creek, May 13, 1992.

	Stability Indicators by Classes							
# Item rated	Excellent		Good		Poor		Fair	
1 Land form slope	Bank slope gradient <30%		Bank slope gradient 30-40%	4	Bank slope gradient 40-60%		Bank slope gradient 60%	
2 Mass Wasting or Failure or potential)	No evidence of past or any potential for future mass wasting into channel.		Infrequent and/or very small. Mostly healed over. Low future potential.	6	Moderate frequency and size, with some raw spots eroded by water during high flows.		Frequent or large, causing sediment nearly yearlong or imminent danger of same.	
3 Debris Jam Potential	Essentially absent from immediate channel area.		Present but mostly small twigs and limbs.		Present, volume and size are both increasing.	6	Moderate to heavy amounts, predominantly larger sizes.	
4 Vegetative Bank Protection	90%+ plant density. Vigor and variety suggests a deep, dense, soil binding, root mass.		70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	6	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.		<50% density plus fewer species and less vigor indicate poor, discontinuous, and shallow root mass.	
5 Channel Capacity	Ample for present plus some increases. Peak flows contained W/D ratio <7.		Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8 to 15.		Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.	3	Inadequate. Overbank flows common. W/D ratio >25.	
6 Bank Rock Content	65%+ with large, angular, boulders 12"+ numerous.		40-65%, mostly small boulders to cobbles 6-12".	4	20-40%, with most in the 3-6" diameter class.		<20% rock fragments of gravel sizes, 1-3" or less.	
7 Obstructions Flow Deflectors Sediment Traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable.		Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.		Moderately frequent, moderately unstable obstructions and deflectors move with high water causing bank cutting and filling of pools.	6	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	
8 Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.		Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".	8	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.		Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	
9 Deposition	Little or no enlargement of channel or point bars.	4	Some new increase in bar formation, mostly from coarse gravels.		Moderate deposition of new gravel and coarse sand on old and some new bars.		Extensive deposits of predominantly fine particles. Accelerated bar development.	
10 Rock Angularity	Sharp edges and corners, plane surfaces roughened.		Rounded corners and edges, surfaces smooth and flat.	2	Corners and edges well rounded in two dimensions.		Well rounded in all dimensions, surfaces smooth.	
11 Brightness	Surfaces dull, darkened, or stained, Generally not "bright".		Mostly dull, but may have up to 35% bright surfaces.	2	Mixture, 50-50% dull and bright, ±15% ie. 35-65%.		Predominantly bright, 65%+ exposed or scoured surfaces.	
12 Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.		Moderately packed with some overlapping.	4	Mostly a loose assortment with no apparent overlap.		No packing evident. Loose assortment, easily moved.	
13 Bottom Size Distribution and Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.		Distribution shift slight. Stable materials 50-80%.	8	Moderate change in sizes. Stable materials 20-50%.		Marked distribution change. Stable materials 0-20%.	
14 Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.		5-30% affected. Scour at constrictions and steepened grades. Some deposition in pools.	12	30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.		More than 50% of the bottom in a state of flux or change nearly yearlong.	
15 Clinging Aquatic Vegetation (Moss and Algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too.		Common. Algal forms in low velocitiy and pool areas. Moss here too and swifter waters.		Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	
	Excellent column total	4	Good column total	56	Fair column total	18	Poor column total	0

Table C.3. Stream reach inventory and channel stability evaluation for the upper reach of Lake Creek, May 13, 1992.

	Stability Indicators by Classes							
# Item rated	Excellent		Good		Poor		Fair	
1 Land form slope	Bank slope gradient <30%	2	Bank slope gradient 30-40%		Bank slope gradient 40-60%		Bank slope gradient 60%	
2 Mass Wasting or Failure or potential)	No evidence of past or any potential for future mass wasting into channel.		Infrequent and/or very small. Mostly healed over. Low future potential.		Moderate frequency and size, with some raw spots eroded by water during high flows.	10	Frequent or large, causing sediment nearly yearlong or imminent danger of same.	
3 Debris Jam Potential	Essentially absent from immediate channel area.		Present but mostly small twigs and limbs.		Present, volume and size are both increasing.		Moderate to heavy amounts, predominantly larger sizes.	8
4 Vegetative Bank Protection	90%+ plant density. Vigor and variety suggests a deep, dense, soil binding, root mass.		70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.		50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	9	<50% density plus fewer species and less vigor indicate poor, discontinuous, and shallow root mass.	
5 Channel Capacity	Ample for present plus some increases. Peak flows contained W/D ratio <7.		Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8 to 15.		Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.		Inadequate. Overbank flows common. W/D ratio >25.	4
6 Bank Rock Content	65%+ with large, angular, boulders 12"+ numerous.	2	40-65%, mostly small boulders to cobbles 6-12".		20-40%, with most in the 3-6" diameter class.		<20% rock fragments of gravel sizes, 1-3" or less.	
7 Obstructions Flow Deflectors Sediment Traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable.		Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	4	Moderately frequent, moderately unstable obstructions and deflectors move with high water causing bank cutting and filling of pools.		Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	
8 Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.		Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".		Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.		Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	15
9 Deposition	Little or no enlargement of channel or point bars.		Some new increase in bar formation, mostly from coarse gravels.		Moderate deposition of new gravel and coarse sand on old and some new bars.		Extensive deposits of predominantly fine particles. Accelerated bar development.	16
10 Rock Angularity	Sharp edges and corners, plane surfaces roughened.		Rounded corners and edges, surfaces smooth and flat.		Corners and edges well rounded in two dimensions.		Well rounded in all dimensions, surfaces smooth.	4
11 Brightness	Surfaces dull, darkened, or stained. Generally not "bright".	1	Mostly dull, but may have up to 35% bright surfaces.		Mixture, 50-50% dull and bright, ±15% ie. 35-65%.		Predominantly bright, 65%+ exposed or scoured surfaces.	
12 Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.		Moderately packed with some overlapping.		Mostly a loose assortment with no apparent overlap.		No packing evident. Loose assortment, easily moved.	8
13 Bottom Size Distribution and Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.		Distribution shift slight. Stable materials 50-80%.		Moderate change in sizes. Stable materials 20-50%.		Marked distribution change. Stable materials 0-20%.	16
14 Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.		5-30% affected. Scour at constrictions and steepened grades. Some deposition in pools.		30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.		More than 50% of the bottom in a state of flux or change nearly yearlong.	20
15 Clinging Aquatic Vegetation (Moss and Algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too.	1	Common. Algal forms in low velocitiy and pool areas. Moss here too and swifter waters.		Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.		Perennial types scarce or absent. Yellow-green, short term bloom may be present.	
	Excellent column total	6	Good column total	4	Fair column total	19	Poor column total	91

Table C.4. Stream reach inventory and channel stability evaluation for the lower reach of Benewah Creek, May 11, 1992.

	Stability Indicators by Classes							
# Item rated	**Excellent**		**Good**		**Poor**		**Fair**	
1 Land form slope	Bank slope gradient <30%	2	Bank slope gradient 30-40%		Bank slope gradient 40-60%		Bank slope gradient 60%	
2 Mass Wasting or Failure or potential)	No evidence of past or any potential for future mass wasting into channel.		Infrequent and/or very small. Mostly healed over. Low future potential.	4	Moderate frequency and size, with some raw spots eroded by water during high flows.		Frequent or large, causing sediment nearly yearlong or imminent danger of same.	
3 Debris Jam Potential	Essentially absent from immediate channel area.		Present but mostly small twigs and limbs.	4	Present, volume and size are both increasing.		Moderate to heavy amounts, predominantly larger sizes.	
4 Vegetative Bank Protection	90%+ plant density. Vigor and variety suggests a deep, dense, soil binding, root mass.	3	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.		50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.		<50% density plus fewer species and less vigor indicate poor, discontinuous, and shallow root mass.	
5 Channel Capacity	Ample for present plus some increases. Peak flows contained W/D ratio <7.		Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8 to 15.	2	Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.		Inadequate. Overbank flows common. W/D ratio >25.	
6 Bank Rock Content	65%+ with large, angular, boulders 12"+ numerous.		40-65%, mostly small boulders to cobbles 6-12".		20-40%, with most in the 3-6" diameter class.	6	<20% rock fragments of gravel sizes, 1-3" or less.	
7 Obstructions Flow Deflectors Sediment Traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable.		Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	4	Moderately frequent, moderately unstable obstructions and deflectors move with high water causing bank cutting and filling of pools.		Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	
8 Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.		Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".		Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	12	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	
9 Deposition	Little or no enlargement of channel or point bars.		Some new increase in bar formation, mostly from coarse gravels.	8	Moderate deposition of new gravel and coarse sand on old and some new bars.		Extensive deposits of predominantly fine particles. Accelerated bar development.	
10 Rock Angularity	Sharp edges and corners, plane surfaces roughened.		Rounded corners and edges, surfaces smooth and flat.		Corners and edges well rounded in two dimensions.	3	Well rounded in all dimensions, surfaces smooth.	
11 Brightness	Surfaces dull, darkened, or stained, Generally not "bright".		Mostly dull, but may have up to 35% bright surfaces.		Mixture, 50-50% dull and bright, ±15% ie. 35-65%.	3	Predominantly bright, 65%+ exposed or scoured surfaces.	
12 Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.		Moderately packed with some overlapping.		Mostly a loose assortment with no apparent overlap.	6	No packing evident. Loose assortment, easily moved.	
13 Bottom Size Distribution and Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.		Distribution shift slight. Stable materials 50-80%.		Moderate change in sizes. Stable materials 20-50%.	10	Marked distribution change. Stable materials 0-20%.	
14 Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.		5-30% affected. Scour at constrictions and steepened grades. Some deposition in pools.	10	30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.		More than 50% of the bottom in a state of flux or change nearly yearlong.	
15 Clinging Aquatic Vegetation (Moss and Algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too.		Common. Algal forms in low velocitiy and pool areas. Moss here too and swifter waters.		Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	
	Excellent column total	5	Good column total	32	Fair column total	43	Poor column total	0

Table C.5. Stream reach inventory and channel stability evaluation for the middle reach of Benewah Creek, May 11, 1992.

	Stability Indicators by Classes							
# Item rated	**Excellent**		**Good**		**Poor**		**Fair**	
1 Land form slope	Bank slope gradient <30%	2	Bank slope gradient 30-40%		Bank slope gradient 40-60%		Bank slope gradient 60%	
2 Mass Wasting or Failure or potential)	No evidence of past or any potential for future mass wasting into channel.		Infrequent and/or very small. Mostly healed over. Low future potential.		Moderate frequency and size, with some raw spots eroded by water during high flows.	9	Frequent or large, causing sediment nearly yearlong or imminent danger of same.	
3 Debris Jam Potential	Essentially absent from immediate channel area.		Present but mostly small twigs and limbs.	4	Present, volume and size are both increasing.		Moderate to heavy amounts, predominantly larger sizes.	
4 Vegetative Bank Protection	90%+ plant density. Vigor and variety suggests a deep, dense, soil binding, root mass.		70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	6	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.		<50% density plus fewer species and less vigor indicate poor, discontinuous, and shallow root mass.	
5 Channel Capacity	Ample for present plus some increases. Peak flows contained W/D ratio <7.		Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8 to 15.	2	Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.		Inadequate. Overbank flows common. W/D ratio >25.	
6 Bank Rock Content	65%+ with large, angular, boulders 12"+ numerous.		40-65%, mostly small boulders to cobbles 6-12".	4	20-40%, with most in the 3-6" diameter class.		<20% rock fragments of gravel sizes, 1-3" or less.	
7 Obstructions Flow Deflectors Sediment Traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable.		Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.		Moderately frequent, moderately unstable obstructions and deflectors move with high water causing bank cutting and filling of pools.	6	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	
8 Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.		Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".	5	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.		Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	
9 Deposition	Little or no enlargement of channel or point bars.		Some new increase in bar formation, mostly from coarse gravels.	6	Moderate deposition of new gravel and coarse sand on old and some new bars.		Extensive deposits of predominantly fine particles. Accelerated bar development.	
10 Rock Angularity	Sharp edges and corners, plane surfaces roughened.		Rounded corners and edges, surfaces smooth and flat.		Corners and edges well rounded in two dimensions.	3	Well rounded in all dimensions, surfaces smooth.	
11 Brightness	Surfaces dull, darkened, or stained, Generally not "bright".	1	Mostly dull, but may have up to 35% bright surfaces.		Mixture, 50-50% dull and bright, ±15% ie. 35-65%.		Predominantly bright, 65%+ exposed or scoured surfaces.	
12 Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	2	Moderately packed with some overlapping.		Mostly a loose assortment with no apparent overlap.		No packing evident. Loose assortment, easily moved.	
13 Bottom Size Distribution and Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	4	Distribution shift slight. Stable materials 50-80%.		Moderate change in sizes. Stable materials 20-50%.		Marked distribution change. Stable materials 0-20%.	
14 Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.		5-30% affected. Scour at constrictions and steepened grades. Some deposition in pools.	12	30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.		More than 50% of the bottom in a state of flux or change nearly yearlong.	
15 Clinging Aquatic Vegetation (Moss and Algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too.		Common. Algal forms in low velocitiy and pool areas. Moss here too and swifter waters.		Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	
	Excellent column total	9	Good column total	44	Fair column total	21	Poor column total	0

Table C.6. Stream reach inventory and channel stability evaluation for the upper reach of Benewah Creek, May 11, 1992.

	Stability Indicators by Classes							
# Item rated	Excellent		Good		Poor		Fair	
1 Land form slope	Bank slope gradient <30%	2	Bank slope gradient 30-40%		Bank slope gradient 40-60%		Bank slope gradient 60%	
2 Mass Wasting or Failure or potential)	No evidence of past or any potential for future mass wasting into channel.	3	Infrequent and/or very small. Mostly healed over. Low future potential.		Moderate frequency and size, with some raw spots eroded by water during high flows.		Frequent or large, causing sediment nearly yearlong or imminent danger of same.	
3 Debris Jam Potential	Essentially absent from immediate channel area.		Present but mostly small twigs and limbs.	4	Present, volume and size are both increasing.		Moderate to heavy amounts, predominantly larger sizes.	
4 Vegetative Bank Protection	90%+ plant density. Vigor and variety suggests a deep, dense, soil binding, root mass.	3	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.		50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.		<50% density plus fewer species and less vigor indicate poor, discontinuous, and shallow root mass.	
5 Channel Capacity	Ample for present plus some increases. Peak flows contained W/D ratio <7.		Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8 to 15.	2	Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.		Inadequate. Overbank flows common. W/D ratio >25.	
6 Bank Rock Content	65%+ with large, angular, boulders 12"+ numerous.		40-65%, mostly small boulders to cobbles 6-12".		20-40%, with most in the 3-6" diameter class.		<20% rock fragments of gravel sizes, 1-3" or less.	8
7 Obstructions Flow Deflectors Sediment Traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable.		Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	4	Moderately frequent, moderately unstable obstructions and deflectors move with high water causing bank cutting and filling of pools.		Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	
8 Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.		Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".		Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.		Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
9 Deposition	Little or no enlargement of channel or point bars.		Some new increase in bar formation, mostly from coarse gravels.		Moderate deposition of new gravel and coarse sand on old and some new bars.	12	Extensive deposits of predominantly fine particles. Accelerated bar development.	
10 Rock Angularity	Sharp edges and corners, plane surfaces roughened.		Rounded corners and edges, surfaces smooth and flat.		Corners and edges well rounded in two dimensions.	3	Well rounded in all dimensions, surfaces smooth.	
11 Brightness	Surfaces dull, darkened, or stained, Generally not "bright".		Mostly dull, but may have up to 35% bright surfaces.		Mixture, 50-50% dull and bright, ±15% ie. 35-65%.		Predominantly bright, 65%+ exposed or scoured surfaces.	4
12 Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.		Moderately packed with some overlapping.		Mostly a loose assortment with no apparent overlap.		No packing evident. Loose assortment, easily moved.	8
13 Bottom Size Distribution and Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.		Distribution shift slight. Stable materials 50-80%.		Moderate change in sizes. Stable materials 20-50%.		Marked distribution change. Stable materials 0-20%.	16
14 Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.		5-30% affected. Scour at constrictions and steepened grades. Some deposition in pools.		30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.	18	More than 50% of the bottom in a state of flux or change nearly yearlong.	
15 Clinging Aquatic Vegetation (Moss and Algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too.		Common. Algal forms in low velocitiy and pool areas. Moss here too and swifter waters.		Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	
	Excellent column total	8	Good column total	10	Fair column total	36	Poor column total	52

Table C.7. Stream reach inventory and channel stability evaluation for the lower reach of Evans Creek, July 21, 1992.

	Stability Indicators by Classes							
# Item rated	Excellent		Good		Poor		Fair	
1 Land form slope	Bank slope gradient <30%		Bank slope gradient 30-40%		Bank slope gradient 40-60%		Bank slope gradient 60%	8
2 Mass Wasting or Failure or potential)	No evidence of past or any potential for future mass wasting into channel.		Infrequent and/or very small. Mostly healed over. Low future potential.		Moderate frequency and size, with some raw spots eroded by water during high flows.		Frequent or large, causing sediment nearly yearlong or imminent danger of same.	12
3 Debris Jam Potential	Essentially absent from immediate channel area.		Present but mostly small twigs and limbs.	4	Present, volume and size are both increasing.		Moderate to heavy amounts, predominantly larger sizes.	
4 Vegetative Bank Protection	90%+ plant density. Vigor and variety suggests a deep, dense, soil binding, root mass.		70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.		50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.		<50% density plus fewer species and less vigor indicate poor, discontinuous, and shallow root mass.	12
5 Channel Capacity	Ample for present plus some increases. Peak flows contained W/D ratio <7.		Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8 to 15.		Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.	3	Inadequate. Overbank flows common. W/D ratio >25.	
6 Bank Rock Content	65%+ with large, angular, boulders 12"+ numerous.		40-65%, mostly small boulders to cobbles 6-12".		20-40%, with most in the 3-6" diameter class.		<20% rock fragments of gravel sizes, 1-3" or less.	8
7 Obstructions Flow Deflectors Sediment Traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable.		Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.		Moderately frequent, moderately unstable obstructions and deflectors move with high water causing bank cutting and filling of pools.	7	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	
8 Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.		Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".		Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	12	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	
9 Deposition	Little or no enlargement of channel or point bars.		Some new increase in bar formation, mostly from coarse gravels.		Moderate deposition of new gravel and coarse sand on old and some new bars.		Extensive deposits of predominantly fine particles. Accelerated bar development.	16
10 Rock Angularity	Sharp edges and corners, plane surfaces roughened.		Rounded corners and edges, surfaces smooth and flat.		Corners and edges well rounded in two dimensions.		Well rounded in all dimensions, surfaces smooth.	4
11 Brightness	Surfaces dull, darkened, or stained, Generally not "bright".	1	Mostly dull, but may have up to 35% bright surfaces.		Mixture, 50-50% dull and bright, ±15% ie. 35-65%.		Predominantly bright, 65%+ exposed or scoured surfaces.	
12 Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.		Moderately packed with some overlapping.		Mostly a loose assortment with no apparent overlap.		No packing evident. Loose assortment, easily moved.	8
13 Bottom Size Distribution and Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.		Distribution shift slight. Stable materials 50-80%.		Moderate change in sizes. Stable materials 20-50%.		Marked distribution change. Stable materials 0-20%.	16
14 Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.		5-30% affected. Scour at constrictions and steepened grades. Some deposition in pools.		30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.		More than 50% of the bottom in a state of flux or change nearly yearlong.	24
15 Clinging Aquatic Vegetation (Moss and Algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too.		Common. Algal forms in low velocitiy and pool areas. Moss here too and swifter waters.		Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.		Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
	Excellent column total	1	Good column total	4	Fair column total	22	Poor column total	112

Table C.8. Stream reach inventory and channel stability evaluation for the middle reach of Evans Creek, July 21, 1992.

# Item rated	Excellent		Good		Poor		Fair	
			Stability Indicators by Classes					
1 Land form slope	Bank slope gradient <30%		Bank slope gradient 30-40%		Bank slope gradient 40-60%		Bank slope gradient 60%	8
2 Mass Wasting or Failure or potential)	No evidence of past or any potential for future mass wasting into channel.		Infrequent and/or very small. Mostly healed over. Low future potential.	6	Moderate frequency and size, with some raw spots eroded by water during high flows.		Frequent or large, causing sediment nearly yearlong or imminent danger of same.	
3 Debris Jam Potential	Essentially absent from immediate channel area.		Present but mostly small twigs and limbs.	4	Present, volume and size are both increasing.		Moderate to heavy amounts, predominantly larger sizes.	
4 Vegetative Bank Protection	90%+ plant density. Vigor and variety suggests a deep, dense, soil binding, root mass.	3	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.		50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.		<50% density plus fewer species and less vigor indicate poor, discontinuous, and shallow root mass.	
5 Channel Capacity	Ample for present plus some increases. Peak flows contained W/D ratio <7.		Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8 to 15.	2	Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.		Inadequate. Overbank flows common. W/D ratio >25.	
6 Bank Rock Content	65%+ with large, angular, boulders 12"+ numerous.		40-65%, mostly small boulders to cobbles 6-12".	4	20-40%, with most in the 3-6" diameter class.		<20% rock fragments of gravel sizes, 1-3" or less.	
7 Obstructions Flow Deflectors Sediment Traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable.	2	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.		Moderately frequent, moderately unstable obstructions and deflectors move with high water causing bank cutting and filling of pools.		Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	
8 Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	4	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".		Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.		Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	
9 Deposition	Little or no enlargement of channel or point bars.		Some new increase in bar formation, mostly from coarse gravels.	6	Moderate deposition of new gravel and coarse sand on old and some new bars.		Extensive deposits of predominantly fine particles. Accelerated bar development.	
10 Rock Angularity	Sharp edges and corners, plane surfaces roughened.		Rounded corners and edges, surfaces smooth and flat.		Corners and edges well rounded in two dimensions.	3	Well rounded in all dimensions, surfaces smooth.	
11 Brightness	Surfaces dull, darkened, or stained, Generally not "bright".		Mostly dull, but may have up to 35% bright surfaces.		Mixture, 50-50% dull and bright, ±15% ie. 35-65%.		Predominantly bright, 65%+ exposed or scoured surfaces.	4
12 Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.		Moderately packed with some overlapping.	4	Mostly a loose assortment with no apparent overlap.		No packing evident. Loose assortment, easily moved.	
13 Bottom Size Distribution and Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.		Distribution shift slight. Stable materials 50-80%.	8	Moderate change in sizes. Stable materials 20-50%.		Marked distribution change. Stable materials 0-20%.	
14 Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.		5-30% affected. Scour at constrictions and steepened grades. Some deposition in pools.	12	30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.		More than 50% of the bottom in a state of flux or change nearly yearlong.	
15 Clinging Aquatic Vegetation (Moss and Algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too.		Common. Algal forms in low velocitiy and pool areas. Moss here too and swifter waters.		Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	
	Excellent column total	9	Good column total	46	Fair column total	6	Poor column total	12

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Table C.9. Stream reach inventory and channel stability evaluation for the upper reach of Evans Creek, July 21, 1992.

	Stability Indicators by Classes							
# Item rated	Excellent		Good		Poor		Fair	
1 Land form slope	Bank slope gradient <30%		Bank slope gradient 30-40%		Bank slope gradient 40-60%		Bank slope gradient 60%	8
2 Mass Wasting or Failure or potential)	No evidence of past or any potential for future mass wasting into channel.	3	Infrequent and/or very small. Mostly healed over. Low future potential.		Moderate frequency and size, with some raw spots eroded by water during high flows.		Frequent or large, causing sediment nearly yearlong or imminent danger of same.	
3 Debris Jam Potential	Essentially absent from immediate channel area.		Present but mostly small twigs and limbs.		Present, volume and size are both increasing.	6	Moderate to heavy amounts, predominantly larger sizes.	
4 Vegetative Bank Protection	90%+ plant density. Vigor and variety suggests a deep, dense, soil binding, root mass.	3	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.		50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.		<50% density plus fewer species and less vigor indicate poor, discontinuous, and shallow root mass.	
5 Channel Capacity	Ample for present plus some increases. Peak flows contained W/D ratio <7.	1	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8 to 15.		Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.		Inadequate. Overbank flows common. W/D ratio >25.	
6 Bank Rock Content	65%+ with large, angular, boulders 12"+ numerous.	2	40-65%, mostly small boulders to cobbles 6-12".		20-40%, with most in the 3-6" diameter class.		<20% rock fragments of gravel sizes, 1-3" or less.	
7 Obstructions Flow Deflectors Sediment Traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable.	2	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.		Moderately frequent, moderately unstable obstructions and deflectors move with high water causing bank cutting and filling of pools.		Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	
8 Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	4	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".		Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.		Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	
9 Deposition	Little or no enlargement of channel or point bars.		Some new increase in bar formation, mostly from coarse gravels.	8	Moderate deposition of new gravel and coarse sand on old and some new bars.		Extensive deposits of predominantly fine particles. Accelerated bar development.	
10 Rock Angularity	Sharp edges and corners, plane surfaces roughened.		Rounded corners and edges, surfaces smooth and flat.	2	Corners and edges well rounded in two dimensions.		Well rounded in all dimensions, surfaces smooth.	
11 Brightness	Surfaces dull, darkened, or stained, Generally not "bright".		Mostly dull, but may have up to 35% bright surfaces.		Mixture, 50-50% dull and bright, ±15% ie. 35-65%.		Predominantly bright, 65%+ exposed or scoured surfaces.	4
12 Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	2	Moderately packed with some overlapping.		Mostly a loose assortment with no apparent overlap.		No packing evident. Loose assortment, easily moved.	
13 Bottom Size Distribution and Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.		Distribution shift slight. Stable materials 50-80%.	8	Moderate change in sizes. Stable materials 20-50%.		Marked distribution change. Stable materials 0-20%.	
14 Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.		5-30% affected. Scour at constrictions and steepened grades. Some deposition in pools.	12	30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.		More than 50% of the bottom in a state of flux or change nearly yearlong.	
15 Clinging Aquatic Vegetation (Moss and Algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too.		Common. Algal forms in low velocitiy and pool areas. Moss here too and swifter waters.		Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	
	Excellent column total	17	Good column total	30	Fair column total	9	Poor column total	12

Table C.10. Stream reach inventory and channel stability evaluation for the lower reach of Alder Creek, May 4, 1992.

# Item rated	Stability Indicators by Classes: Excellent		Good		Poor		Fair	
1 Land form slope	Bank slope gradient <30%		Bank slope gradient 30-40%	4	Bank slope gradient 40-60%		Bank slope gradient 60%	
2 Mass Wasting or Failure or potential)	No evidence of past or any potential for future mass wasting into channel.		Infrequent and/or very small. Mostly healed over. Low future potential.	6	Moderate frequency and size, with some raw spots eroded by water during high flows.		Frequent or large, causing sediment nearly yearlong or imminent danger of same.	
3 Debris Jam Potential	Essentially absent from immediate channel area.		Present but mostly small twigs and limbs.	5	Present, volume and size are both increasing.		Moderate to heavy amounts, predominantly larger sizes.	
4 Vegetative Bank Protection	90%+ plant density. Vigor and variety suggests a deep, dense, soil binding, root mass.	3	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.		50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.		<50% density plus fewer species and less vigor indicate poor, discontinuous, and shallow root mass.	
5 Channel Capacity	Ample for present plus some increases. Peak flows contained W/D ratio <7.	1	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8 to 15.		Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.		Inadequate. Overbank flows common. W/D ratio >25.	
6 Bank Rock Content	65%+ with large, angular, boulders 12"+ numerous.	2	40-65%, mostly small boulders to cobbles 6-12".		20-40%, with most in the 3-6" diameter class.		<20% rock fragments of gravel sizes, 1-3" or less.	
7 Obstructions Flow Deflectors Sediment Traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable.	2	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.		Moderately frequent, moderately unstable obstructions and deflectors move with high water causing bank cutting and filling of pools.		Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	
8 Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	4	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".		Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.		Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	
9 Deposition	Little or no enlargement of channel or point bars.	4	Some new increase in bar formation, mostly from coarse gravels.		Moderate deposition of new gravel and coarse sand on old and some new bars.		Extensive deposits of predominantly fine particles. Accelerated bar development.	
10 Rock Angularity	Sharp edges and corners, plane surfaces roughened.		Rounded corners and edges, surfaces smooth and flat.	2	Corners and edges well rounded in two dimensions.		Well rounded in all dimensions, surfaces smooth.	
11 Brightness	Surfaces dull, darkened, or stained, Generally not "bright".		Mostly dull, but may have up to 35% bright surfaces.	2	Mixture, 50-50% dull and bright, ±15% ie. 35-65%.		Predominantly bright, 65%+ exposed or scoured surfaces.	
12 Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	2	Moderately packed with some overlapping.		Mostly a loose assortment with no apparent overlap.		No packing evident. Loose assortment, easily moved.	
13 Bottom Size Distribution and Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	4	Distribution shift slight. Stable materials 50-80%.		Moderate change in sizes. Stable materials 20-50%.		Marked distribution change. Stable materials 0-20%.	
14 Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	6	5-30% affected. Scour at constrictions and steepened grades. Some deposition in pools.		30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.		More than 50% of the bottom in a state of flux or change nearly yearlong.	
15 Clinging Aquatic Vegetation (Moss and Algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too.		Common. Algal forms in low velocitiy and pool areas. Moss here too and swifter waters.	2	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.		Perennial types scarce or absent. Yellow-green, short term bloom may be present.	
	Excellent column total	28	Good column total	21	Fair column total	0	Poor column total	0

Table C.11. Stream reach inventory and channel stability evaluation for the middle reach of Alder Creek, May 7, 1992.

	Stability Indicators by Classes							
# Item rated	**Excellent**		**Good**		**Poor**		**Fair**	
1 Land form slope	Bank slope gradient <30%		Bank slope gradient 30-40%	4	Bank slope gradient 40-60%		Bank slope gradient 60%	
2 Mass Wasting or Failure or potential)	No evidence of past or any potential for future mass wasting into channel.	3	Infrequent and/or very small. Mostly healed over. Low future potential.		Moderate frequency and size, with some raw spots eroded by water during high flows.		Frequent or large, causing sediment nearly yearlong or imminent danger of same.	
3 Debris Jam Potential	Essentially absent from immediate channel area.	2	Present but mostly small twigs and limbs.		Present, volume and size are both increasing.		Moderate to heavy amounts, predominantly larger sizes.	
4 Vegetative Bank Protection	90%+ plant density. Vigor and variety suggests a deep, dense, soil binding, root mass.	3	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.		50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.		<50% density plus fewer species and less vigor indicate poor, discontinuous, and shallow root mass.	
5 Channel Capacity	Ample for present plus some increases. Peak flows contained W/D ratio <7.	1	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8 to 15.		Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.		Inadequate. Overbank flows common. W/D ratio >25.	
6 Bank Rock Content	65%+ with large, angular, boulders 12"+ numerous.		40-65%, mostly small boulders to cobbles 6-12".		20-40%, with most in the 3-6" diameter class.	6	<20% rock fragments of gravel sizes, 1-3" or less.	
7 Obstructions Flow Deflectors Sediment Traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable.		Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	3	Moderately frequent, moderately unstable obstructions and deflectors move with high water causing bank cutting and filling of pools.		Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	
8 Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	2	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".		Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.		Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	
9 Deposition	Little or no enlargement of channel or point bars.	2	Some new increase in bar formation, mostly from coarse gravels.		Moderate deposition of new gravel and coarse sand on old and some new bars.		Extensive deposits of predominantly fine particles. Accelerated bar development.	
10 Rock Angularity	Sharp edges and corners, plane surfaces roughened.		Rounded corners and edges, surfaces smooth and flat.	2	Corners and edges well rounded in two dimensions.		Well rounded in all dimensions, surfaces smooth.	
11 Brightness	Surfaces dull, darkened, or stained, Generally not "bright".	1	Mostly dull, but may have up to 35% bright surfaces.		Mixture, 50-50% dull and bright, ±15% ie. 35-65%.		Predominantly bright, 65%+ exposed or scoured surfaces.	
12 Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.		Moderately packed with some overlapping.	4	Mostly a loose assortment with no apparent overlap.		No packing evident. Loose assortment, easily moved.	
13 Bottom Size Distribution and Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	4	Distribution shift slight. Stable materials 50-80%.		Moderate change in sizes. Stable materials 20-50%.		Marked distribution change. Stable materials 0-20%.	
14 Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	6	5-30% affected. Scour at constrictions and steepened grades. Some deposition in pools.		30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.		More than 50% of the bottom in a state of flux or change nearly yearlong.	
15 Clinging Aquatic Vegetation (Moss and Algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too.		Common. Algal forms in low velocity and pool areas. Moss here too and swifter waters.		Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	
	Excellent column total	24	Good column total	13	Fair column total	9	Poor column total	0

Table C.12. Stream reach inventory and channel stability evaluation for the upper reach of Alder Creek, May 4, 1992.

	Stability Indicators by Classes							
# Item rated	**Excellent**		**Good**		**Poor**		**Fair**	
1 Land form slope	Bank slope gradient <30%	2	Bank slope gradient 30-40%		Bank slope gradient 40-60%		Bank slope gradient 60%	
2 Mass Wasting or Failure or potential)	No evidence of past or any potential for future mass wasting into channel.	3	Infrequent and/or very small. Mostly healed over. Low future potential.		Moderate frequency and size, with some raw spots eroded by water during high flows.		Frequent or large, causing sediment nearly yearlong or imminent danger of same.	
3 Debris Jam Potential	Essentially absent from immediate channel area.	2	Present but mostly small twigs and limbs.		Present, volume and size are both increasing.		Moderate to heavy amounts, predominantly larger sizes.	
4 Vegetative Bank Protection	90%+ plant density. Vigor and variety suggests a deep, dense, soil binding, root mass.	3	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.		50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.		<50% density plus fewer species and less vigor indicate poor, discontinuous, and shallow root mass.	
5 Channel Capacity	Ample for present plus some increases. Peak flows contained W/D ratio <7.	1	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8 to 15.		Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.		Inadequate. Overbank flows common. W/D ratio >25.	
6 Bank Rock Content	65%+ with large, angular, boulders 12"+ numerous.		40-65%, mostly small boulders to cobbles 6-12".		20-40%, with most in the 3-6" diameter class.		<20% rock fragments of gravel sizes, 1-3" or less.	6
7 Obstructions Flow Deflectors Sediment Traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable.		Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.		Moderately frequent, moderately unstable obstructions and deflectors move with high water causing bank cutting and filling of pools.	5	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	
8 Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.		Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".	8	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.		Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	
9 Deposition	Little or no enlargement of channel or point bars.	4	Some new increase in bar formation, mostly from coarse gravels.		Moderate deposition of new gravel and coarse sand on old and some new bars.		Extensive deposits of predominantly fine particles. Accelerated bar development.	
10 Rock Angularity	Sharp edges and corners, plane surfaces roughened.		Rounded corners and edges, surfaces smooth and flat.	2	Corners and edges well rounded in two dimensions.		Well rounded in all dimensions, surfaces smooth.	
11 Brightness	Surfaces dull, darkened, or stained, Generally not "bright".		Mostly dull, but may have up to 35% bright surfaces.	2	Mixture, 50-50% dull and bright, ±15% ie. 35-65%.		Predominantly bright, 65%+ exposed or scoured surfaces.	
12 Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.		Moderately packed with some overlapping.		Mostly a loose assortment with no apparent overlap.	6	No packing evident. Loose assortment, easily moved.	
13 Bottom Size Distribution and Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	4	Distribution shift slight. Stable materials 50-80%.		Moderate change in sizes. Stable materials 20-50%.		Marked distribution change. Stable materials 0-20%.	
14 Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	6	5-30% affected. Scour at constrictions and steepened grades. Some deposition in pools.		30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.		More than 50% of the bottom in a state of flux or change nearly yearlong.	
15 Clinging Aquatic Vegetation (Moss and Algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too.		Common. Algal forms in low velocitiy and pool areas. Moss here too and swifter waters.		Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	
	Excellent column total	25	Good column total	12	Fair column total	14	Poor column total	6

APPENDIX D

Table D.1. Calculated geometric mean, sorting coefficient, fredle index value and percent survival for each substrate sample collected In Lake Creek during 1992.

STREAM Lower Lake	LEFT				RIGHT				MEAN % SURVIVAL
	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	32.1	1.4	23.1	80.5	42.4	1.2	34.5	>100.0	90.3
site 2	18.7	3.8	4.9	90.2	14.7	5.1	2.9	72.6	81.4
site 3	18.2	4.5	4.1	78.7	17.7	4.6	3.9	77.5	78.1
site 4	18.1	3.3	5.4	81.9	11.9	6.5	1.8	59.2	70.6
site 5	8.6	7.7	1.1	55.7	10.4	12.7	0.8	45.4	50.6
Average	*19.1*	4.7	7.7	*77.4*	*19.4*	6.0	8.8	70.9	

Middle Lake	LEFT				RIGHT				% SURVIVAL
	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	32.4	1.4	22.9	73.6	30.2	2.2	14.0	82.9	78.3
site 2	20.9	5.3	3.3	66.2	38.9	8.3	3.1	87.4	76.8
site 3	17.6	2.5	8.4	82.5	14.8	1.3	1.1	69.9	76.2
site 4	10.0	7.7	1.3	60.8	13.1	9.1	1.4	69.9	65.4
site 5	12.1	13.6	0.9	51.2	11.6	10.8	1.1	50.8	51.0
Average	*18.6*	*6.1*	7.4	*66.0*	*21.7*	*6.3*	*9.9*	*72.2*	

Upper Lake	LEFT				RIGHT				% SURVIVAL
	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	51.9	1.0	51.9	>100.0	18.0	3.7	4.9	76.5	88.3
site 2	18.4	4.0	4.6	52.7	1.2	1.4	0.8	co.0	26.4
site 3	27.9	2.0	13.9	69.9	27.4	2.0	13.7	73.6	71.8
site 4	24.0	2.8	8.7	81.4	11.0	21.4	0.5	30.5	56.0
site 5	0.6	1.9	0.3	co.0	20.6	3.0	6.9	55.0	27.5
Average	24.6	2.3	15.9	60.8	15.6	6.3	5.4	47.1	

Table D.l. continued...

Bozard	LEFT				RIGHT				% SURVIVAL
	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	0.7	3.0	0.2	<0.0	4.3	12.0	0.4	co.0	<0.0
site 2	0.6	2.7	0.2	co.0	0.6	2.4	0.2	co.0	<o.o
site 3	3.3	13.2	0.2	<0.0	6.4	9.1	0.7	23.1	11.6
site 4	0.9	4.6	0.2	<o.o	0.9	4.8	0.2	co.0	<0.0
site 5	11.6	2.6	4.4	83.5	12.1	2.8	4.3	86.1	84.8
A verage	3.4	5.2	1.0	16.7	4.9	6.2	1.2	21.8	19.3
West Fork Lake	**LEFT**				**RIGHT**				**% SURVIVAL**
	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	0.9	2.3	0.4	<o.o	0.8	2.6	0.3	co.0	<o.o
site 2	0.7	2.4	0.3	<o.o	0.7	2.5	0.3	co.0	<o.o
site 3	0.9	3.1	0.3	co.0	0.8	3.8	0.2	<0.0	co.0
site 4	1.1	2.5	0.4	co.0	1.1	1.7	0.7	co.0	co.0
site 5	2.1	4.1	0.5	<o.o	2.0	4.6	0.4	54.3	27.2
Average	1.1	2.9	0.4	<0.0	1.7	3.0	0.4	10.9	5.4
Upper Upper Lake	**LOWER (Left)**				**UPPER (Right)**				**% SURVIVAL**
	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	0.6	8.0	0.1	<o.o	0.5	8.3	0.1	co.0	<o.o
site 2	0.5	7.2	0.1	co.0	1.5	106.7	0.0	co.0	<o.o
site 3	0.3	3.1	0.1	<o.o	0.6	5.1	0.1	<0.0	<0.0
site 4	1.1	17.3	0.1	co.0	0.5	6.0	0.1	co.0	<0.0
site 5	0.5	3.3	0.2	co.0					<o.o
A verage	0.6	7.8	0.7	<o. 0	0.8	31.5	0.7	<0.0	<o.o

Table D.2. Calculated geometric mean, sorting coefficient, frdle index value and percent survival for each substrate sample collected In Benewah Creek during 1992.

STREAM	LEFT				RIGHT				MEAN % SURVIVAL
Lower Benewah	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	32.1	3.0	7.3	89.2	23.2	3.5	6.6	78.8	84.0
site 2	20.6	3.7	5.6	81.4	20.6	3.9	5.3	81.4	81.4
site 3	7.8	5.0	1.6	58.0	31.4	2.0	15.7	90.2	74.1
site 4	40.5	1.1	36.7	>100.0	34.5	1.8	18.7	>100.0	>100.0
site 5	40.7	1.1	36.9	>100.0	49.3	1.1	44.7	>100.0	>100.0
Mean	26.3	2.8	17.6	85.7	31.8	2.5	18.2	90.1	87.9
STREAM Middle Benewah	**LEFT**				**RIGHT**				**MEAN % SURVIVAL**
	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	45.0	1.1	40.8	>100.0	54.2	1.0	54.2	>100.0	>100.0
site 2	40.2	1.5	30.0	>100.0	15.2	2.6	5.8	>100.0	>100.0
site 3	14.9	2.7	5.5	>1 00.0	22.0	2.5	8.7	>100.0	>100.0
site 4	26.3	2..3	11.6	>100.0	35.6	1.5	24.4	>100.0	>100.0
site 5	15.2	2.1	7.1	>100.0	5.7	6.3	0.9	83.8	83.8
Mean	28.3	1.9	19.0	>100.0	26.5	2.8	18.8	96.7	96.7
STREAM Upper Benewah	**LEFT**				**RIGHT**				**MEAN % SURVIVAL**
	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	30.8	2.0	15.0	>100.0	8.3	4.8	1.7	77.2	88.6
site 2	6.2	4.0	1.6	63.5	12.5	2.5	5.1	83.1	73.3
site 3	5.0	7.5	0.7	16.4	5.4	6.1	0.9	28.2	22.3
site 4	28.1	2.9	9.6	85.7	13.3	2.3	5.9	88.6	87.2
site 5	6.8	5.4	1.3	63.3	16.8	5.3	3.2	67.7	65.5
Average	15.4	4.4	5.6	57.2	11.3	4.2	3.4	69.0	67.4

Table D.3. Calculated geometric mean, sorting coefficient, fredle index value and % survival for- each substrate sample collected from Alder Creek during 1992.

STREAM Lower Alder	LEFT				RIGHT				MEAN % SURVIVAL
	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	25.4	3.6	7.1	90.8	25.0	2.8	8.9	91.2	91 .o
site 2	25.3	3.3	7.8	89.8	25.0	3.0	8.4	87.1	88.4
site 3	20.4	4.4	4.7	77.9	25.3	2.8	9.0	88.0	82.9
site 4	27.4	2.7	10.2	90.9	25.5	2.8	9.1	>100	95.4
site 5	22.3	3.3	6.9	90.6	23.3	3.3	7.2	>100	95.3
Average	24.2	3.5	7.3	88.0	25.2	2.9	8.5	93.3	
STREAM Middle Alder	**LEFT**				**RIGHT**				**MEAN % SURVIVAL**
	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	37.8	1.3	28.2	91.9	39.9	1.2	33.6	>100	96.0
site 2	28.4	2.2	13.0	91.2	33.7	1.6	21.1	91.8	91.5
site 3	40.3	1.1	35.2	>100	38.4	1.3	30.5	>100	>100
site 4	28.1	1.7	14.1	>100	28.0	3.0	9.3	>100	>100
site 5	28.8	2.3	12.5	>100	35.0	1.9	18.5	>100	>100
Average	32.7	1.7	20.6	96.6	35.0	1.8	22.6	98.4	
STREAM Upper Alder	**LEFT**				**RIGHT**				**MEAN % SURVIVAL**
	D_g	S_o 2.6	F	%S	D_g	S_o 1.9	F	%S	X
site 1	27.7	4.0	10.8	82.1	35.5	4.7	18.8	89.5	85.8
site 2	18.1		4.5	89.2	16.0		3.4	80.7	85.0
site 3	8.1	6.2	1.3	63.7	11.7	2.4	4.8	87.2	75.5
site 4	38.1	1.1	33.4	86.7	31 .1	2.0	15.6	91.5	89.1
site 5	13.9	4.0	3.5	>100	16.8	4.7	3.6	90.2	95.1
Average	21.2	3.6	10.7	84.3	22.2	3.1	9.2	87.8	

Table D.4. Calculated geometric mean, sorting coefficient, fredle index value and percent survival for each substrate sample collected in Evans Creek during 1992.

STREAM									MEAN
Lower Evans	LEFT				RIGHT				% SURVIVAL
	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	0.3	1.5	0.2	co.0	0.3	1.2	0.2	<0.0	co.0
site 2	1.4	4.2	0.3	26.7	1.2	4.4	0.3	56.8	41.8
site 3	14.9	7.0	2.1	76.9	14.3	5.8	2.5	87.5	82.2
site 4	15.3	7.9	1.9	77.9	14.5	7.1	2.1	77.2	77.6
site 5	29.8	2.2	13.6	90.1	29.9	2.1	14.1	99.8	94.9
Average	12.3	4.6	3.6	54.4	12.0	4.1	3.8	64.3	59.3
STREAM									MEAN
Middle Evans	LEFT				RIGHT				% SURVIVAL
	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	34.4	1.7	20.6	91.6	37.1	1.8	20.4	93.5	92.6
site 2	17.7	5.3	3.3	68.2	18.4	4.7	3.9	75.1	71.7
site 3	18.8	4.0	4.7	52.5	18.2	2.8	6.6	88.8	70.7
site 4	14.8	3.5	4.2	79.8	14.0	8.8	1.6	86.1	82.9
site 5	11.2	8.3	1.3	71.8	10.8	10.8	1.0	78.3	75.1
Average	19.4	4.6	6.8	72.8	19.7	5.8	6.7	84.4	78.6
STREAM									MEAN
Upper Evans	LEFT				RIGHT				% SURVIVAL
	D_g	S_o	F	%S	D_g	S_o	F	%S	X
site 1	9.8	12.7	0.7	67.9	10.3	11.0	0.93	40.8	54.4
site 2	21.2	4.4	4.8	90.2	22.1	2.5	8.7	90.4	90.3
site 3	22.4	2.6	8.5	86.5	21.8	3.9	5.6	88.5	87.5
site 4	27.8	2.3	11.9	99.9	30.8	2.3	13.6	99.8	99.8
site 5	25.6	2.8	9.2	80.4	25.5	2.5	10.0	86.9	83.7
Average	21.4	5.0	7.0	85.0	22.1	4.4	7.8	81.3	83.1

APPENDIX E

Table E.l. Total number and relative abundance (%) of each species caught during relative abundance electrofishing surveys on Lake Creek during May, 1992.

Site Shock time (min)	Lower 20	Middle 34	Upper 42
Cutthroat trout		2	
Rainbow x cutthroat	1		
TOTAL	1	2	0

Table E.2. Total number and relative abundance (%) of each species caught during relative abundance electrofishing surveys on Lake Creek during September, 1992.

Site Shock time (min)	Lower 51	Middle 25	Upper 42
Cutthroat trout	4 (2.1)		4 (100.0)
Sculpin spp.	28 (14.7)	250 (77.2)	
Dace spp.	158 (83.2)	74 (22.8)	
TOTAL	*190*	324	4

Table E.3. Total number and relative abundance (%) of each species caught during relative abundance electrofishing surveys on Benewah Creek during May, 1992.

Site Shock time (min)	Lower 38	Middle 32	Upper -2'8
Cutthroat trout	8 (29.6)	6	10 (83.3)
Eastern brook trout			2 (16.7)
Longnose sucker	12 (44.4)		
Norther squawfish	2 (7.4)		
Redside shiner	5 (18.5)		
TOTAL	27	6	12

Table E.4. Total number and relative abundance (%) of each species caught during relative abundance electrofishing surveys on Benewah Creek during July, 1992.

Site Shock time (min)	Lower 28	Middle 40	Upper 39
Cutthroat trout		4	
TOTAL	0	4	0

Table ES. Total number and relative abundance (%) of each species caught during relative abundance electrofishing surveys on Benewah Creek during September, 1992.

Site Shock time (min)	Lower 63	Middle 62	Upper 37
Cutthroat trou	3 (1.8)	5 (1.9)	2 (0.6)
Largemouth bass	113 (66.1)		
Longnose sucker	4 (2.3)	2 (0.7)	4 (1.1)
Redside shiner	31 (18.1)	134 (49.8	168 (47.5)
Sculpin spp.		1 (0.4)	1 (0.3)
Dace spp.	20 (11.7)	127 (47.2)	179 (50.6)
TOTAL	171	269	354

Table E.6. Total number and relative abundance (%) of each species caught during relative abundance electrofishing surveys on Evans Creek during **May**, 1992.

Site Shock time (min)	Lower 30	Middle 33	Upper 40
Cutthroat trout	2	8	13
TOTAL	2	8	13

Table E.7. Total number and relative abundance (%) of each species caught during relative abundance electrofishing surveys on Evans Creek during July, 1992.

Site Shock time (min)	Lower 42	Middle 49	Upper 42
Cutthroat trout		44	18
TOTAL	0	44	18

Table E.8. Total number and relative abundance (%) of each species caught during relative abundance electrofishing surveys on Evans Creek during September, 1992.

Site Shock time (min)	Lower 30	Middle 82	Upper 66
Cutthroat trout		93 (98.9)	60 (100.0)
Eastern brook trout		1 (1.1)	
Largemouth bass	1 (50.0)		
Pumpkinseed	1 (50.0)		
TOTAL	2	94	60

Table E.9. Total number and relative abundance (%) of each species caught during relative abundance electrofishing surveys on Alder Creek during **May,** 1992.

Site Shock time (min)	Lower 65	Middle 29	Upper 74
Cutthroat trout	6 (11.8)	4 (20.0)	3 (3.9)
Eastern brook trout	5 (9.8)	8 (40.0)	31 (40.3)
Rainbow x cutthroat	1 (2.0)		
Rainbow trout			1 (1.3)
Longnose sucker	2 (3.9)		
Scuipin spp.	34 (66.7)	8 (40.0)	42 (54.5)
Dace spp.	3 (5.9)		
TOTAL	51	20	77

Table E.lO. Total number and relative abundance (%) of each species caught during relative abundance electrofishing surveys on Alder Creek during July, 1992.

Site Shock time (min)	Lower	Middle	Upper
Cutthroat trout		2	
Eastern Brook trout			9
Sculpin spp.			
Dace spp.			
TOTAL		2	9

Table E.ll. Total number and relative abundance (%) of each species caught during relative abundance electrofishing surveys on Alder Creek during September, 1992.

Site Shock time (min)	Lower 64	Middle 78	Upper 94
Cutthroat trout	4 (57.1)	43 (87.8)	1 (1.6)
Eastern brook trout	3 (42.9)	6 (12.2)	60 (98.4)
TOTAL	7	49	61